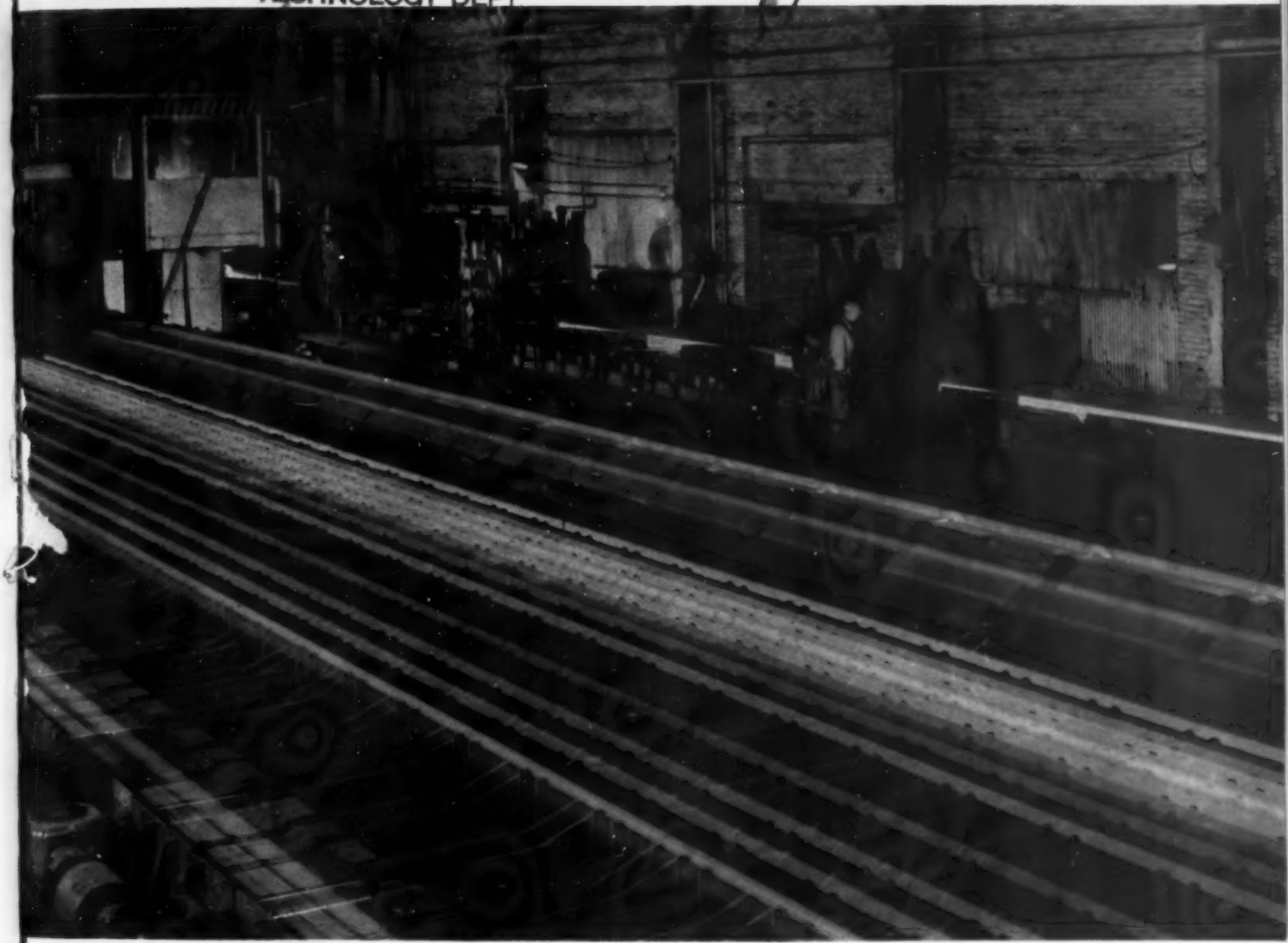
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

DECEMBER, 1952

TECHNOLOGY DEPT

TABLE OF CONTENTS, Page 51



Complete Rolling Mill Installations

SLABBING MILLS
UNIVERSAL MILLS
PLATE MILLS
HOT STRIP MILLS
COLD STRIP MILLS
TEMPER MILLS

Mills complete with Auxiliary Equipment

★ ★ ★

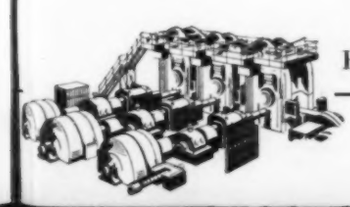
CONTINENTAL CHIPPER
ROLL LATHES
SPECIAL MACHINERY

BLOOMING MILLS
STRUCTURAL MILLS
RAIL MILLS
BILLET MILLS
ROD MILLS
MERCHANT MILLS

CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

WELDMENTS—fabricated steel plate, or cast-weld design.



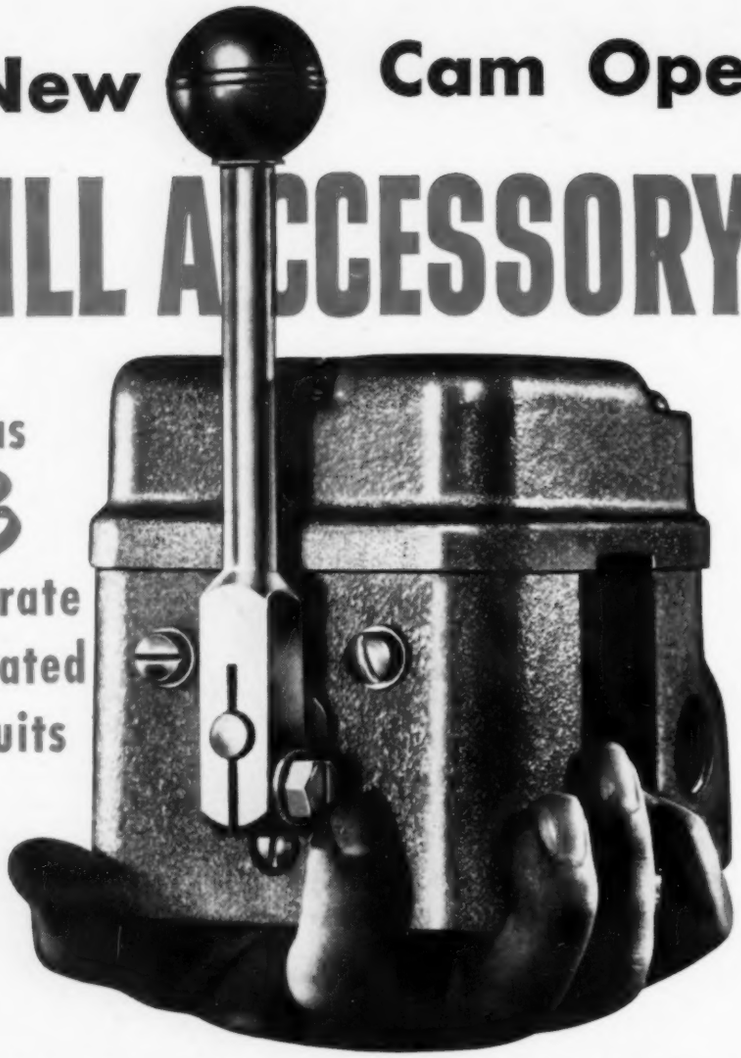
Plants at
East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.

CHICAGO • PITTSBURGH

CONTINENTAL
Foundry & Machine
Company

PUBLIC LIBRARY
DEC 10 1952
DETROIT

New Cam Operated MILL ACCESSORY MASTER

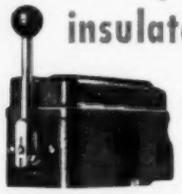


Has 3 separate insulated circuits

"FIVE BY FIVE"

Actual size of case 5½ x 5¼ x 5½

Also in 6 separate insulated circuits



Case measures 5½ x 5¼ x 8⅛

The new Cutler-Hammer Mill Accessory Master has been designed for the many steel mill applications where a cam operated type master switch of very small dimensions is required. This new small master is available with either 3 or 6 separate insulated circuits; cast iron case for surface mounting and in skeleton or sheet metal case for back-of-panel or bench-board flush mounting.

Five standard models are available for these usual types of magnetic controllers:

1. Single speed reversing without low voltage protection in the 3 circuit master.
2. Single speed reversing with low voltage protection in the 3 circuit master.
3. Two speed reversing without low voltage protection in the 3 circuit master.
4. Two speed non-reversing with low voltage protection in the 3 circuit master.
5. Single or two speed non-reversing or reversing with or without low voltage protection in the 6 circuit master.

In addition, both the 3 circuit and 6 circuit master may be had with "daisy-petal" twist-off cam elements adaptable to special circuit requirements . . . which enable you to stock a supply of these masters and tailor each to the requirements of each application.

The switch is provided with double break bridging contacts, molded arc-resistant arcing chambers. The switch has positive star wheel action with readily adjustable star wheel tension. Star wheel cam and roller, and switch cams and rollers, are case hardened. The cam shaft is mounted on self-aligning ball bearings. Handle can also be furnished as self-centering from either or both directions. The clamp-on type handle is readily adjustable to any angular position. The cast iron case of the surface type enclosure has conduit openings in both sides and one in the bottom. The switch is easy to wire, with solderless type lugs; each terminal is arranged for two wires. Rugged construction assures low maintenance. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

where can YOU use this new mill accessory master?

HERE ARE BUT A FEW OF MANY PRESENT USES:

Blowers	Lifts	Pickling Tanks
Conveyors	Saws	
Electric Heaters	Machine Tools	Sizing Mills
Kick-offs	Mandrel Extractors	Solenoid Valves
Levelers		

A pair of pliers does the trick!

When You Tailor This Master To The Job

When there are special circuit requirements to be met, both the 3 circuit and 6 circuit masters are available with "daisy-petal" twist-off cam elements which can be "tailored" to the needs of the specific job. Petals can be twisted off with a pair of pliers to form any cam arrangement.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 29, No. 12.

THE AETNA-STANDARD **ENGINEERING** COMPANY

Leading Engineers and Builders of...

CONTINUOUS COATING LINES

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England—Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Castellvi, Inc., New York, N. Y.—Mexico, Central and South America.

Societe de Constructions de Montbard, Paris, France—France, Belgium, Holland, Luxembourg, Switzerland.

Demag Aktiengesellschaft, Duisburg, Germany—Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

Compagnia Italiana Forme Acciaio, Milano, Italy—Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan—Japan.

Hale & Kullgren, Inc., Akron, Ohio—Representative for the Rubber Industry.

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

Aetna-Standard

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Plants in Warren, Ohio · Ellwood City, Pennsylvania

FROM THE VIEWPOINT of operations, costs, and management, National Rolls are a long term investment in roll satisfaction. They turn out top quality work at low cost per ton. The care and precision that go into their manufacture are directly reflected in their dependable performance in the stands. Try them and see.

THE NATIONAL ROLL & FOUNDRY COMPANY
Avonmore, Pennsylvania

SPECIALISTS IN IRON AND ALLOY IRON ROLLS AND CASTINGS

NOW...BETTER LONGER LASTING PROTECTION

...with new and improved TEXACO MEROPA LUBRICANT

For years, steel men have looked on *Texaco Meropa Lubricant* as the ideal protection for their enclosed reduction gears. Now — because Texaco engineers keep their eyes constantly peeled for ways of improvement — you can count on it to give even better protection.

First of all, the EP characteristics of *Texaco Meropa Lubricant* have been stepped up — and the increased protection lasts longer, as proved by Timken Test and actual field service. The new and improved *Texaco Meropa Lubricant* does not separate in service, storage or centrifuging. Its high EP is not affected by high operating temperatures. Its exceptional adhesiveness is not affected by moisture.

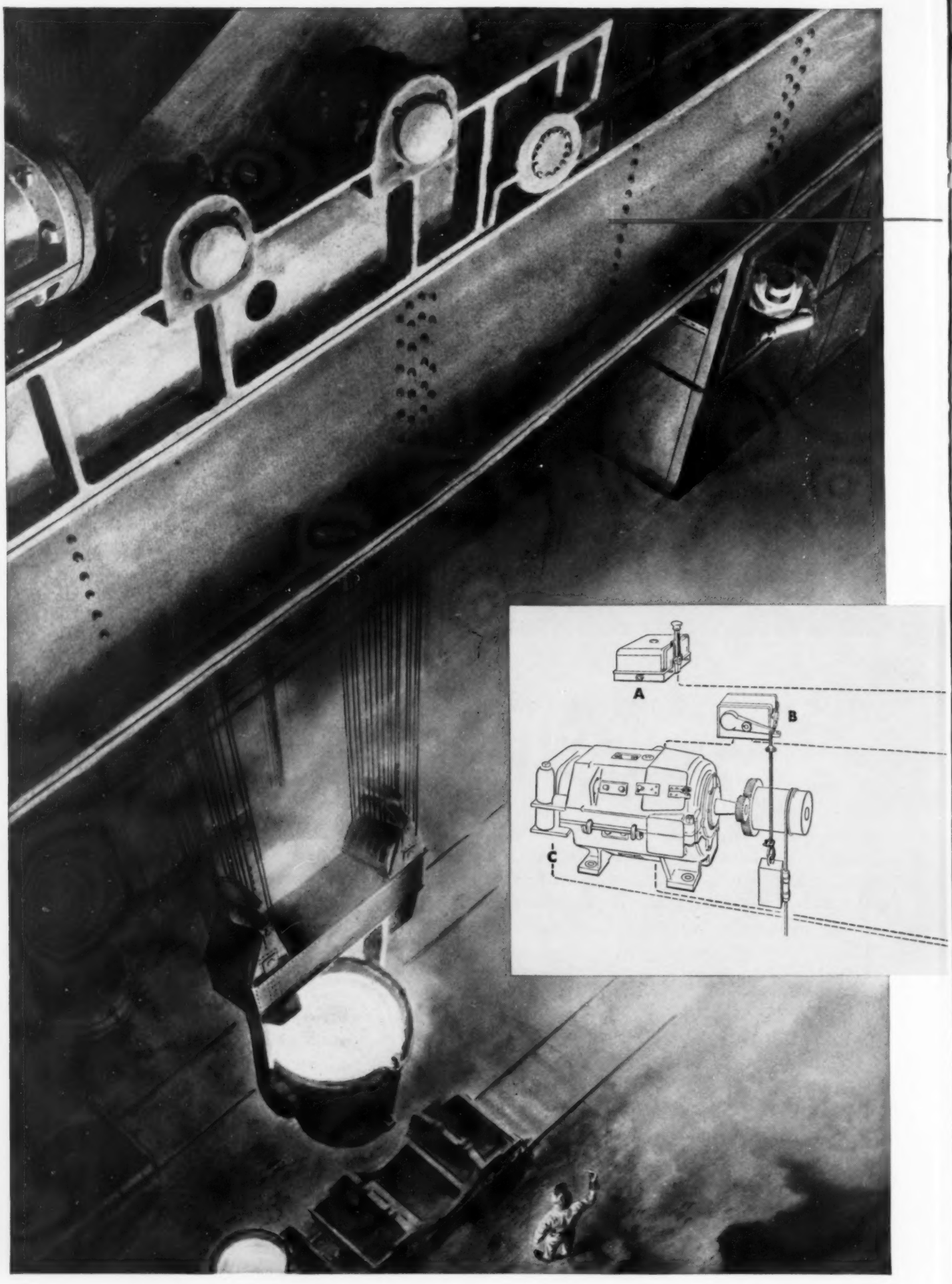
In addition, the new and improved *Texaco Meropa Lubricant* has greater-than-ever resistance to oxidation. It does not thicken in service, does not foam, and is non-corrosive to bearings. There is a complete line of *Texaco Meropa Lubricants* to assure longer gear and bearing life, lower maintenance costs.

Let a Texaco Lubrication Engineer help you get greater efficiency and reduce maintenance costs throughout your mill. Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO Meropa Lubricants
FOR STEEL MILL GEAR DRIVES

Faithfully yours 50 *for Fifty Years*

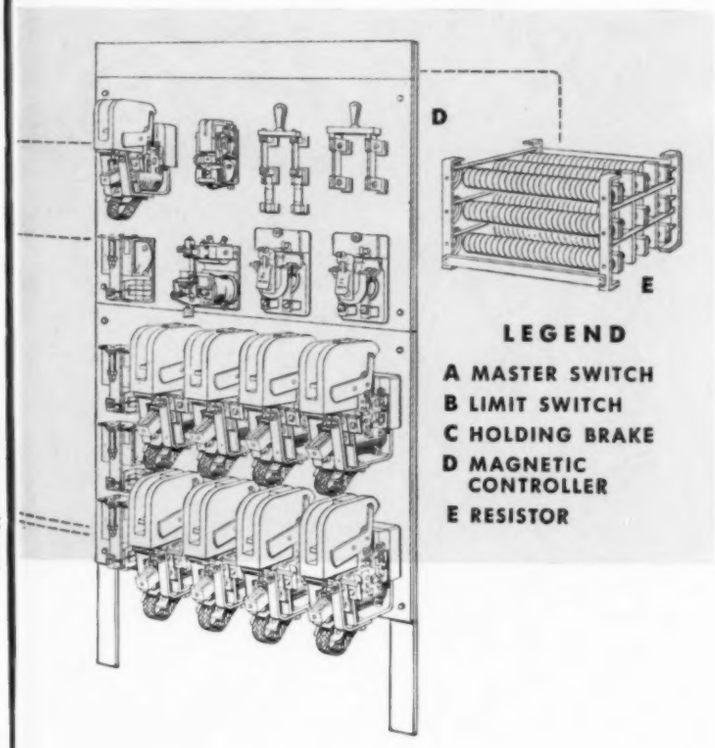
TUNE IN . . . TEXACO STAR THEATER starring MILTON BERLE, on television Tuesday nights. METROPOLITAN OPERA radio broadcasts Saturday afternoons.


A
B
C

MILL RATED muscle for heavy hoisting

Steel mill crane hoist control must have the stamina to take ceaseless beatings. It must be built of components that are mill rated . . . that keep functioning regardless of exposure to dust, dirt, heat, cold and round-the-clock hard service.

The Westinghouse D-C Constant Voltage Crane Hoist Control meets these requirements. It is built to stand up to the daily abuse found in most steel mill operations. Heavy-duty, mill-type electrical equipment is used throughout. The Type M contactors and series-wound, 600-series, d-c motor are mill rated. Dependable operation is further assured by the basic simplicity of the control system.



OPERATING CHARACTERISTICS ARE COMPLETE AND FLEXIBLE

Loads Slip Into Place due to proper proportioning of speed increments between master switch points and selection of correct resistor connections.

Slow-Speed Hoisting Is Available with empty hook. In lowering, suitable kickoff torque is obtained with careful resistor design enabling the motor to reach steady-state speed quickly without overshoot.

High Lowering Speeds Are Available when required. The high-speed lowering point has an independent adjustment to facilitate closer control at these high speeds.

Standard Control Panel contains only nine contactors and four timing relays in addition to protective equipment. All are front mounted for easy accessibility. All are standard units.

New Heavy-Duty Contactors and a combined control system and resistor design, that prevent excessive current peaks during transitions or while plugging, prolong equipment life.

Get this Descriptive Booklet B-5420

Full descriptive information on all components of the Westinghouse D-C Constant Voltage Crane Hoist Control is contained in this free booklet. Your Westinghouse representative has a copy for you. Or, you can get a copy by writing direct to: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-27017

YOU CAN BE SURE...IF IT'S

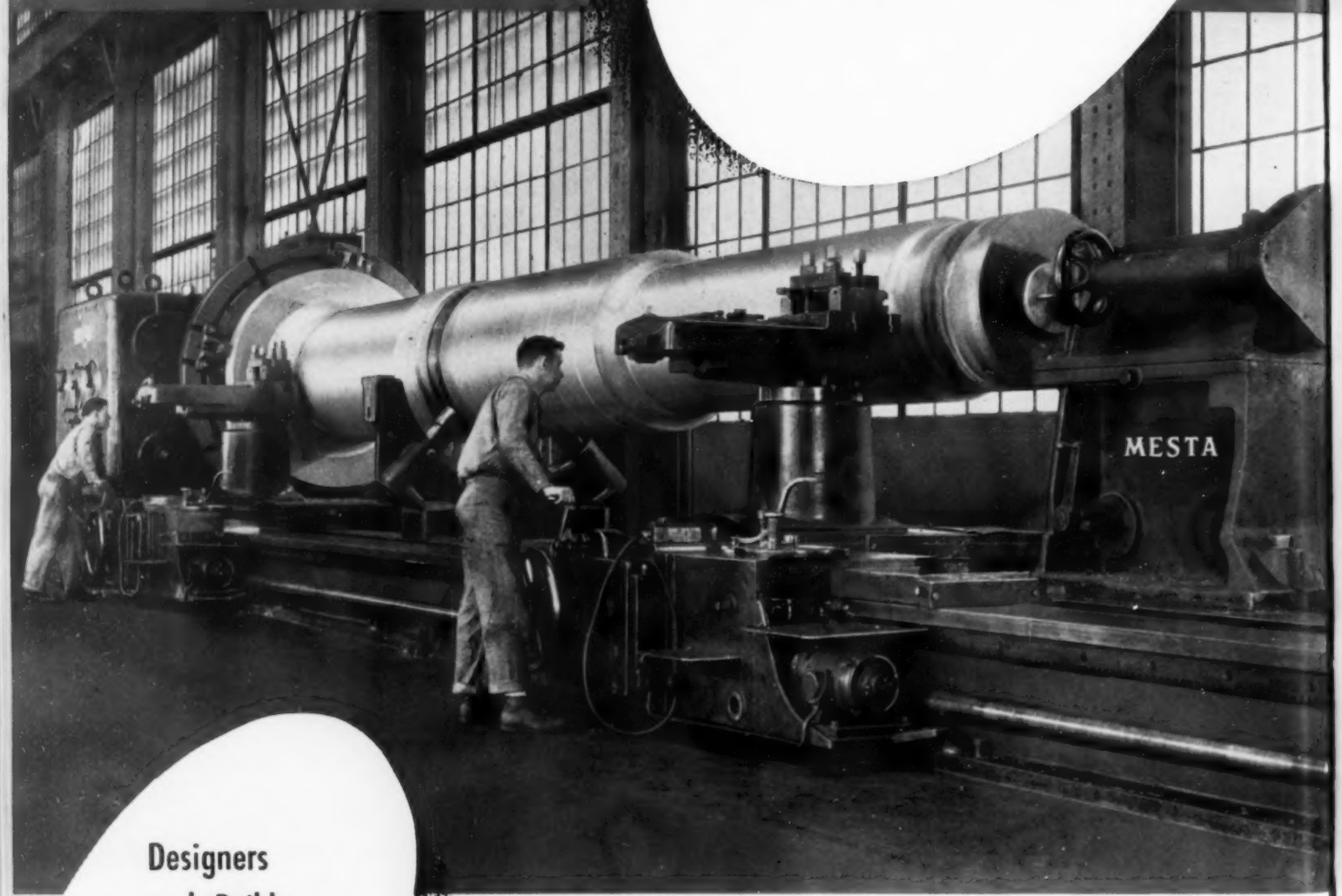
Westinghouse

CRANE CONTROLS

MACHINE SHOPS at MESTA

LATHES...

Machining Forged Steel Rotor Shaft on a MESTA Heavy Duty Lathe



Designers and Builders of Complete Steel Plants

MESTA MACHINE COMPANY
Pittsburgh, Pa.

®AAF

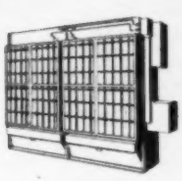
Steel mill dust is death on main drive motors. If not eliminated from the motor rooms, this air-borne saboteur causes shut-downs at the power source that take a costly toll in tonnage. That's why the air today in most steel mill motor rooms is supplied dust-free and "super-clean" by AAF equipment. Clean air is a must for maximum steel production.

Write for "Dust, Dollars and Dividends"... the dramatic story of dust, its problems and their profitable solution.

American Air Filter

COMPANY, INC.

387 Central Ave., Louisville 8, Ky. • American Air Filter of Canada, Ltd., Montreal, P.Q.
Plants in Louisville, Ky. and Moline, Ill.

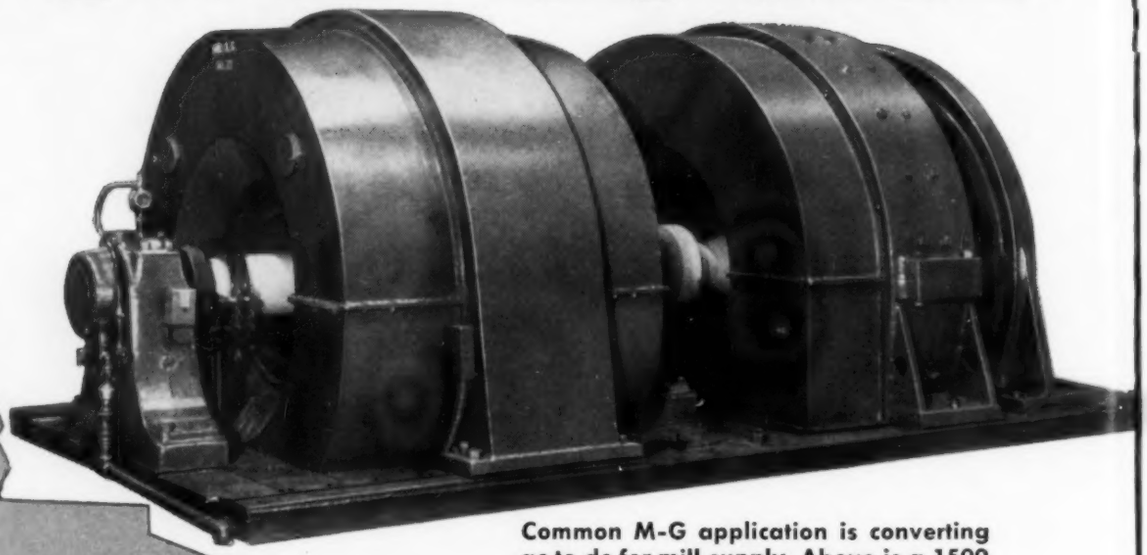


ELECTRONIC PRECIPITATORS

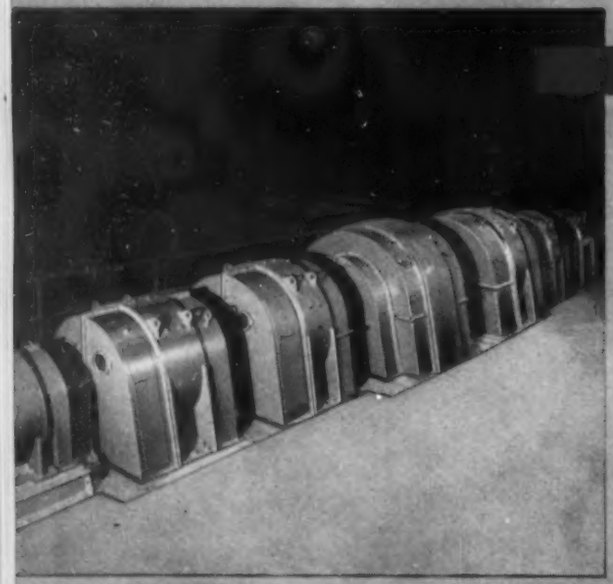
AIR FILTERS

ROTO-CLONE DUST COLLECTORS

From Coast



Common M-G application is converting ac to dc for mill supply. Above is a 1500 kw synchronous set in eastern mill.



WEST

This 8-machine 2000 kw M-G set supports a two stand, four high tin temper mill with generators opposite their mill motors.

MIDWEST

A 56-inch, four stand tandem cold reduction mill is supported by this 7-machine 7750 kw synchronous motor-generator set.

EAST

Three 3-machine 6000 kw synchronous M-G sets supporting six finishing stand motors in a large East Coast steel rolling mill.

TEMPER MILL

Three midwestern single stand temper mills are supported by these M-G sets. Synchronous motors of 1750 hp drive each set.

to Coast!

ALLIS-CHALMERS M-G SETS ARE WIDELY USED IN SUPPORT OF STEEL MILL DC DRIVES

MAJOR STEEL PRODUCERS from Coast to Coast use Allis-Chalmers motor-generator sets. This nationwide acceptance in heavy duty service is proof of their durability and quality.

These representative M-G sets indicate the wide variety in design and size available. Allis-Chalmers has long experience with steel mill needs — having built M-G sets for all current applications — and will build special for any new requirement that may arise.

Motor-generator sets give you:

1. Power factor correction.
2. Regenerative braking.
3. Quick starting for emergency demand.

Only Allis-Chalmers gives you M-G sets with the exclusive *Frog-Leg* armature winding that ***eliminates injurious commutator sparking.*** *Frog-Leg* winding connects bars of equal potential through the winding itself . . . producing a perfectly equalized winding without the use of cross-connectors.

For full details on this heavy duty steel mill rotating equipment, ask for M-G Set Bulletin 05B6032A and Large DC Motor Bulletin 05B6002A. For your copies, just call the nearest A-C office or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3920

Frog-Leg is an Allis-Chalmers trademark.

PICKLING LINE

A pickling line in an eastern steel mill is supported by this 4-machine 1375 kw, 720 rpm synchronous M-G set.

RECORD BREAKER

A motor room, completely equipped by Allis-Chalmers, powered this 80-inch western hot strip mill to a new annual world tonnage record.

ALLIS-CHALMERS

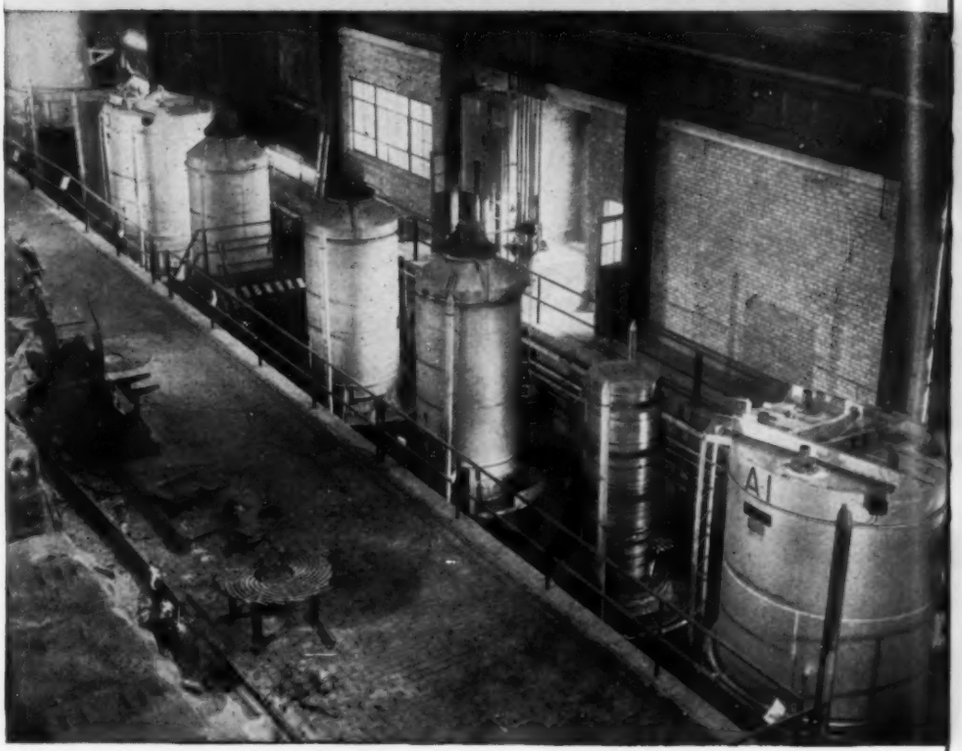
Power, Electrical, Processing Equipment for Iron and Steel

WILSON *Single stack, portable base convection annealing furnaces*

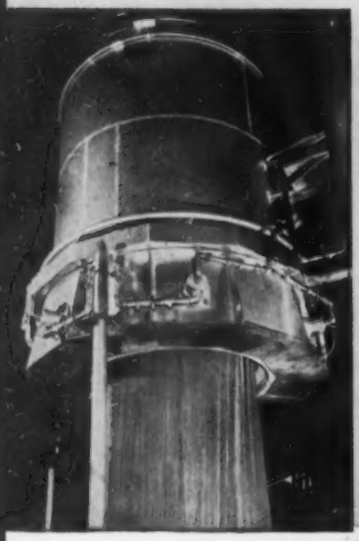
WILSON Single Stack, Portable Base Annealing Furnaces have many advantages, a few of which are shown in the pictures below.

Other advantages are the use of light cranes, faster turnover, higher heat input per stack, and production doubled as compared to multiple-stack furnaces.

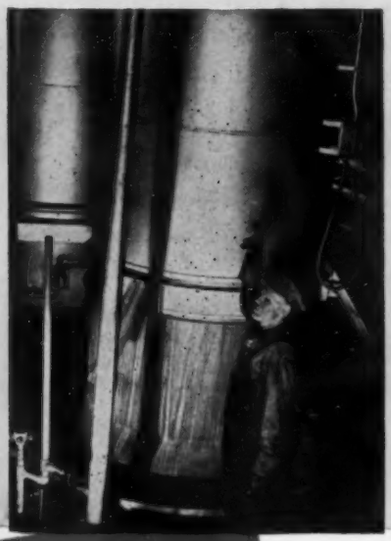
TYPICAL INSTALLATION OF SINGLE STACK FURNACES



QUICK HANDLING



LOW LABOR COST



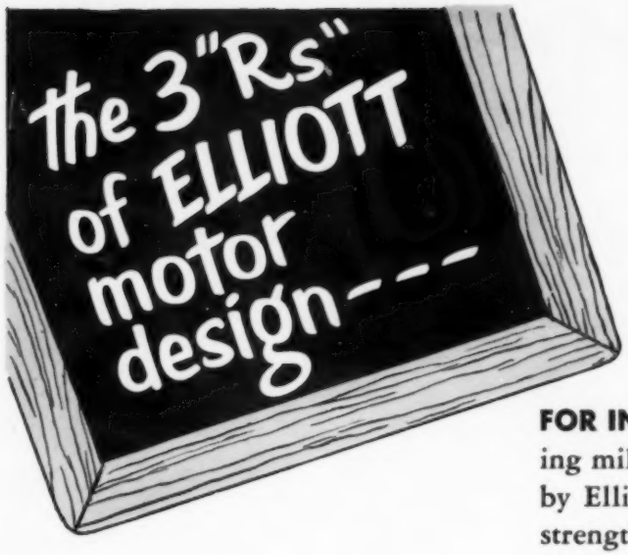
ONE INNER COVER MOVEMENT

MAXIMUM LOADING

Lee Wilson **ENGINEERING** *Co., Inc.*

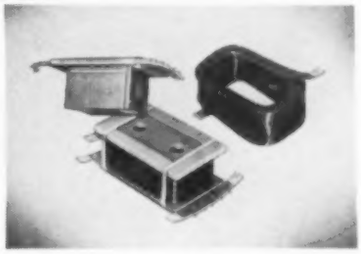
20005 WEST LAKE ROAD • CLEVELAND, OHIO
Telephone ED-1-6600

BELL TYPE FURNACES ★ RADIANT TUBE HEATING ★ ANNEALING PROCESSES



RUGGED REFINED and RELIABLE

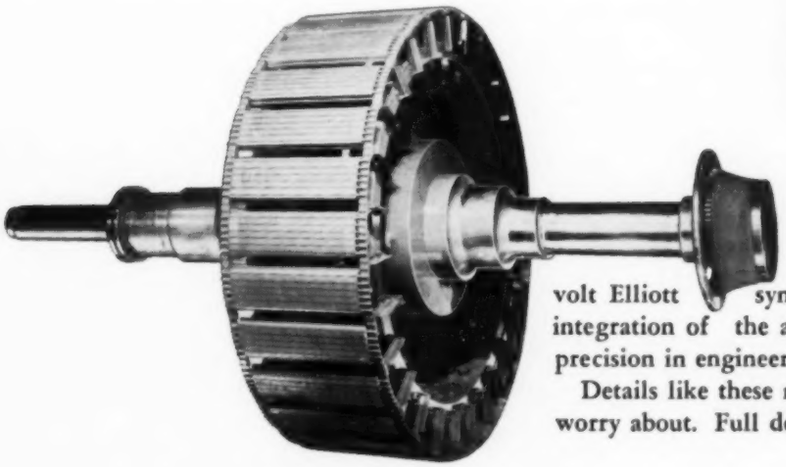
FOR INSTANCE—take a big synchronous motor for piercing mill drive service. Fundamental ruggedness is assured by Elliott "Fabri-Steel" construction with its crack-proof strength, extreme stiffness, and design flexibility. From there on individual details "carry the ball." Here are some of the more important features:



FIELD COILS are edge-wound copper strap, formed, annealed, flattened, dipped and baked with several coats of insulating varnish. Riveted extensions of the pole head support the coil.

STARTING WINDING BARS are of sectional form and material adapted to starting torque required, are inserted into slots in pole faces, and silver alloy brazed to heavy, flat end ring segments for low resistance and an enduring joint.

FIELD LEADS in larger motors are of heavy strap copper, held by insulated studs. Note the heads of the heavy bolts which are threaded through a solid bar in the field coil, tightened with a torque wrench, and finally tack-welded.



TYPICAL ROTOR for a 5000-hp, 257-rpm, 13,800 volt Elliott synchronous motor illustrates the integration of the above features plus painstaking precision in engineering and workmanship.

Details like these make motors you don't have to worry about. Full details in Bulletin P-B-5000.

ELLIOTT Company

DEPT. IS

Ridgway Division

RIDGWAY, PA.

R2-3

Plants at: JEANNETTE, PA. • RIDGWAY, PA.
AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

It will pay you to take a good look

at the

BROWN PRESSURE GAUGE

LIKE all other products that bear the Honeywell name, the Brown Pressure Gauge has established a reputation for sound design, trouble-free performance, and flexibility . . . of practical importance to superintendents, engineers and instrument men. The Brown Pressure Gauge is available with a variety of measuring elements, each designed for maximum performance in a particular pressure or vacuum range. The availability of the elements in various materials, the ease of range change, the interchangeability of components, *plus* the easy accessibility of parts . . . all add up to a convenience that means simplified operation and maintenance for any application.

This instrument can be supplied with one, two, or three pens . . . permitting combinations of pressure, temperature and flow without sacrificing simplicity. And, the desired control form can be obtained from the electronic vane type which permits two or three-position electric control . . . or the pneumatic type which permits on-off, proportional, or proportional plus automatic reset control.

Take a good look at all the features of the Brown Pressure Gauge . . . and then call in your local Honeywell engineering representative for a discussion of their utilization in your plant.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa.

● *Important Reference Data*

Write for catalog 7000, "Pressure and Vacuum Gauges" . . . and for Catalog 74-3, "Furnace Pressure Controllers."

1 FOR HIGH PRESSURE.
Brown spiral pressure elements consist of a series of Bourdon tubes joined end to end and wound as a flat spiral. Available in bronze, steel or stainless steel . . . specially heat-treated for accuracy and long life . . . with ample torque and over-range capacity. For pressures from 18 to 4000 psi.

2 FOR INTERMEDIATE PRESSURE.
Spring and bellows assembly consists of a brass or stainless steel bellows inside a shell, acting against a calibrated spring when pressure is applied to the bellows. A rod transmits bellows motion to the recording pen. Ample sensitivity for pressures from 100 inches of water to 40 psi.

3 FOR LOW PRESSURES.
Relatively large brass bellows, with internal pressure connection, acts against an externally mounted spring. For vacuum and compound ranges a stainless steel spring is mounted in tandem to oppose the partial vacuum. For pressure ranges from 5 to 90 inches of water.

4 FOR FURNACE PRESSURE.
A pair of inverted bells immersed in oil are connected to the furnace tap and to ambient atmosphere near the tap point. The bells are suspended from a balance beam mounted on hardened pivots. The assembly weighs each slightest change in furnace draft. For ranges as small as 0.2 inches of water.

5 FOR ABSOLUTE PRESSURE.
Evacuated bellows of brass or stainless steel containing a calibrated spring is mounted opposing a measuring bellows to which the pressure is applied. Resulting movement between the two bellows is transmitted to the recording pen. Ranges from 0 to 60 inches of mercury absolute.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

H HONEYWELL

Seasons Greetings
made with brick!

● Those bells that ring out Yule . . . the electric train under the tree . . . the piles and piles of packages—most everything we enjoy at Christmas owes its origin, in part, to *refractory* brick.

● Without refractory brick to line the furnaces of industry there would be no heat, light or power, no paper, no metal, no manufacturing, no transportation.

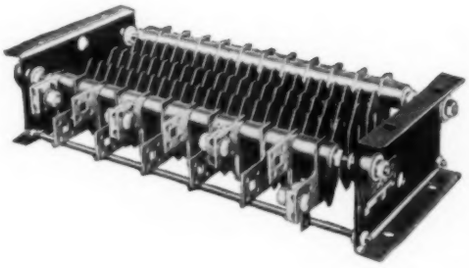
● Next to agriculture, there is no more vital contribution to the economy of our nation than such heat-resisting refractories products as those made by Grefco. From Grefco mines and plants—here and overseas—General Refractories Company is supplying brick, mortars, plastics and castables to serve our nation in times of peace and in times of problem.

● At this time of year let us hope it will be peace. But whatever problem we must face, let's make sure American men and American industry are ready to measure up!

General Refractories Company

PHILADELPHIA

The welded grid assembly is shown here as a unit resting on narrow iron straps above its end frame, support rods, and spacers.



Cut maintenance with
Bulletin 942-A
TAB-WELD Plate Resistors

The alloy-steel used in these plate resistors has negligible resistance-change between cold and maximum working temperatures. In section form, the EC&M TAB-WELD design *maintains the original OHMIC value* of the section, unlike that of any other resistor section. TAB-WELD Resistor Sections are unequalled in that they do *not* depend upon end-clamping nut pressure for a continuous electrical path.

Also, there's *no burning* in concealed areas—at grid-eyes or at tap-plates. Note, too, the convenience of the tap-plates—welded in position. To shift the external lead-wire, only the terminal-block need be moved. The terminal-blocks are grooved to accommodate several sizes of wire, or flat-bus may be bolted to the terminal-plates.

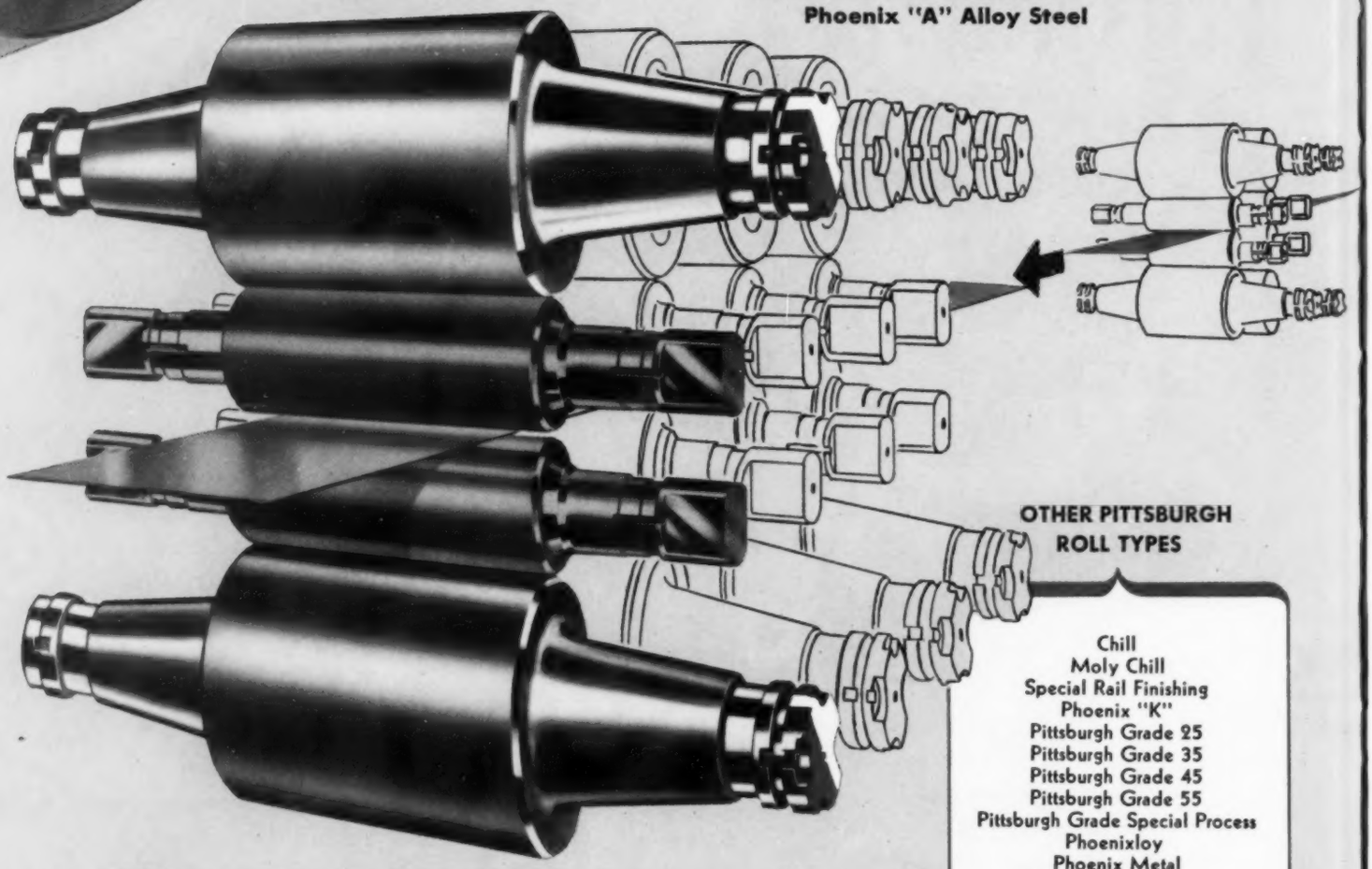
THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO

PHOENIX "A" Alloy Steel ROLLS are color marked for specific uses in rolling . . .

STRIP AND PLATE HOT MILL BACK-UP ROLLS

FINISHING MILL STANDS
Phoenix "A" Alloy Steel
Phoenix "A" Special Alloy Steel

ROUGHING MILL STANDS
Phoenix "A" Alloy Steel



OTHER PITTSBURGH ROLL TYPES

Chill
Moly Chill
Special Rail Finishing
Phoenix "K"
Pittsburgh Grade 25
Pittsburgh Grade 35
Pittsburgh Grade 45
Pittsburgh Grade 55
Pittsburgh Grade Special Process
Phoenixloy
Phoenix Metal
Phoenix Metal Master
Carbon Steel

P.R.W.

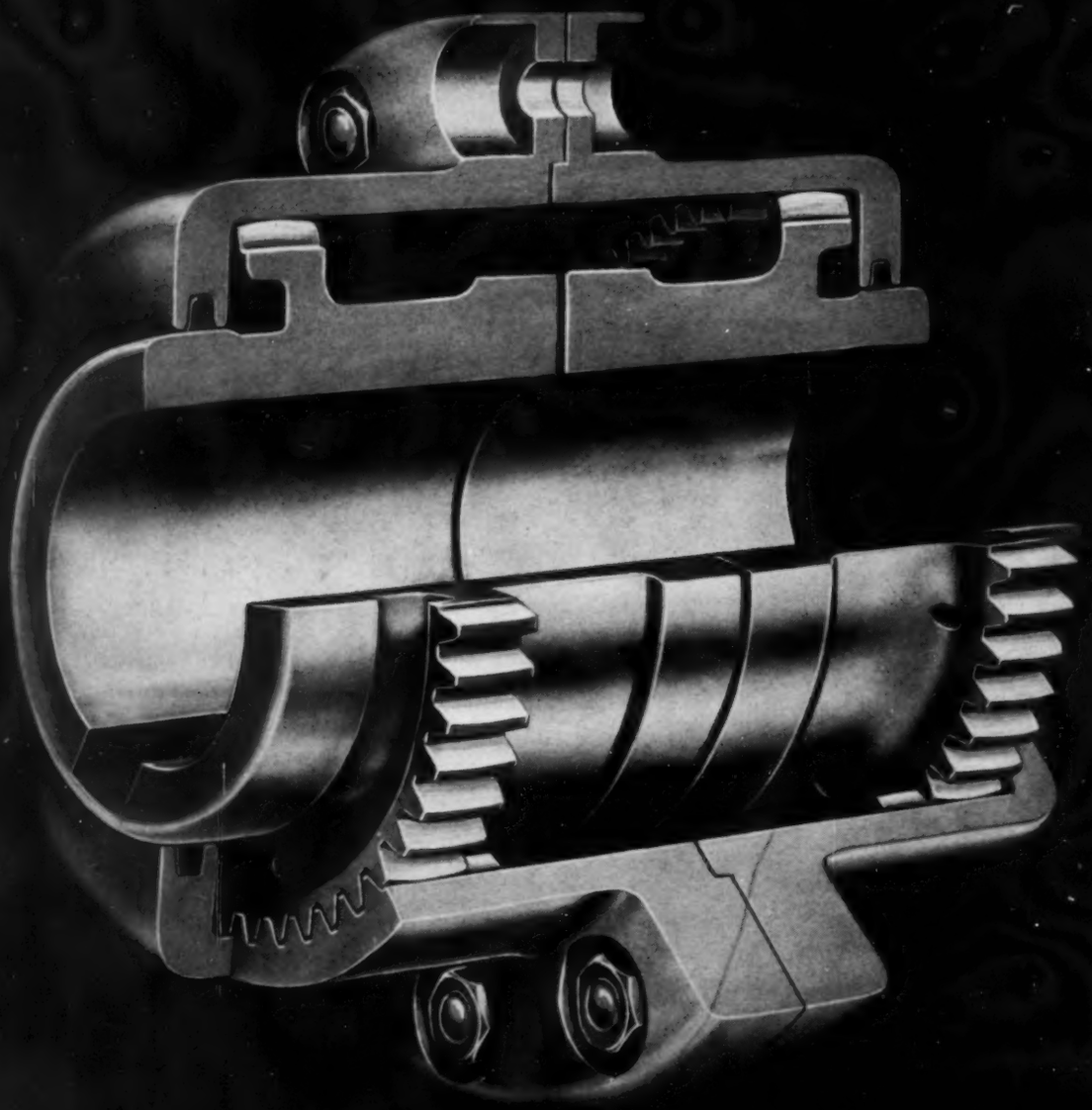
PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION of BLAW-KNOX COMPANY • PITTSBURGH, PA.

United Engineering and Foundry Company

PITTSBURGH, PENNSYLVANIA

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

NUMBER 7 OF A SERIES

How Gulf Periodic Consultation Service helps rolling mills cut lubrication and maintenance costs

—*the right lubricants selected for special applications*

Having trouble finding the right lubricant for a new unit of equipment or for some unusual operating condition? Discuss your problem with a Gulf Sales or Staff Engineer! Chances are that he has had previous experience with similar problems, and can be of practical assistance to you.

This is just one phase of the plan known as Gulf Periodic Consultation Service. For additional information, call in a Gulf Sales Engineer or send the coupon below.

GULF SERVES INDUSTRY

Gulf Oil Corporation · Gulf Refining Company ISE
719 Gulf Building, Pittsburgh 30, Pa.

Please send me, without obligation, a copy of the booklet "Gulf Periodic Consultation Service."

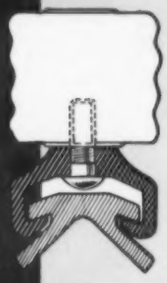
Name .....

Company .....

Title .....

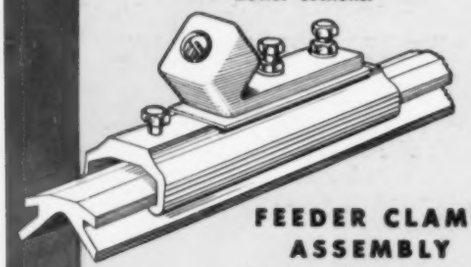
Address .....

The Keystone INTEGRATED ALUMINUM* Conductor System



HANGER SECTION
Conductor free to slide within support, allowing for expansion and contraction.

JOINT PLATE AND BOND ASSEMBLY
Non-loosening spring-type splice plate provides excellent electrical and mechanical joint characteristics between conductor sections.



FEEDER CLAMP ASSEMBLY
features a bimetal separator that eliminates galvanic corrosion between copper terminal and aluminum surface, providing foolproof, long-lasting connection.

LOWER COST

LIGHTER WEIGHT, HIGHER EFFICIENCY

SAFER ENCLOSURES

An integrated power supply system designed to complement the best materials handling equipment—1000 amperes capacity for heavy duty systems . . . economical for use on control circuits.

The Keystone Aluminum Conductor System is now being employed in outstanding installations, after having been developed through years of research in the laboratory and industry. It has been carefully designed to solve the troublesome problems formerly encountered.

The light weight of this conductor system reduces costs of installation, insulators and supporting structures. Its non-corrosive qualities permit use on sensitive control circuits. Longer contact life. Compact design saves space, permits better protection. All components are pre-fabricated. Available complete with brackets and enclosures. No copper boosters nor priorities needed. Easily engineered, installed and maintained.

*Domestic and Foreign Patents Pending

Write today for new, illustrated 4-page folder on Keystone Integrated Aluminum Conductor System.

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

More plate...less wait...from leveller on TIMKEN® bearings

TO insure continuous sheet leveling production, Mesta Machine Company mounts the backing-up rolls of its spindle-driven levellers on Timken® tapered roller bearings.

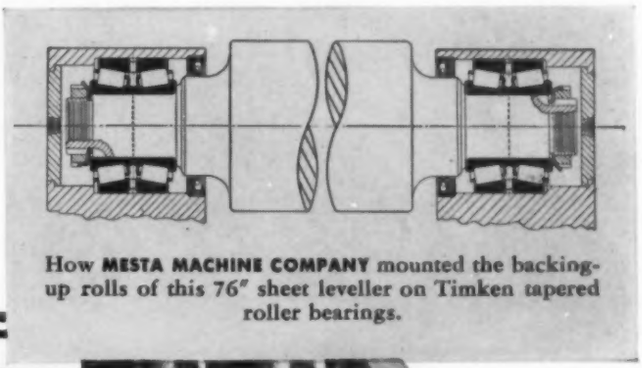
Timken bearings hold shafts in rigid alignment. They reduce drag between rolls because of their true rolling motion and incredibly smooth surface finish. As a result, rolls start quicker even when subjected to terrific separating forces.

Due to their tapered construction, Timken bearings take both radial and thrust loads in any combination. Special thrust units are eliminated. And mounting or changing rolls is simpler, quicker.

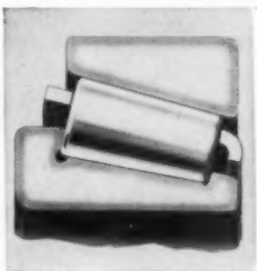
Line contact between the rollers and races of Timken bearings permit extra load-carrying capacity. Because they hold roll and housing concentric, they make closures more effective. Lubricant stays in—dirt and moisture stay out.

Timken bearings are now used on the back up rolls of practically all levellers. Make sure the bearings in the machines you build or buy are stamped with the trade-mark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **MESTA MACHINE COMPANY** mounted the backing-up rolls of this 76" sheet leveller on Timken tapered roller bearings.



GREATER LOAD AREA

Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION ✳

Sea water...secret of more steel!

THE secret of improved open hearth furnace bottom performance—and increased ingot production for you—is high purity periclase derived from sea water magnesia.

Higher in MgO, lower in impurities, this sea water *periclase* is the heart of Permanente 165 ramming mix.

Proved superior by many of the industry's most progressive companies, Permanente 165 *retains highest strength at operating temperatures*—gives maximum refractoriness and maximum resistance to chemical attack.

Pre-shrunk for high density, the sea water periclase of patented Permanente 165 is bonded to *full depth* by crystal bridging—a solid phase reaction.

Result: protection from costly breakthroughs, less down-time for repairs between heats, more tonnage per year!

YOUR Kaiser refractory engineer will give prompt attention to your refractory problem—will offer, where desired, research, design and installation service to give you maximum production most economically. Write for descriptive literature on Permanente 165 and on the companion ramming mix, Permanente 84. Principal sales offices: *Chemical Division*, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California. First National Tower, Akron 8, Ohio.

Kaiser Chemicals

Pioneers in Modern Basic Refractories

Basic Refractory Brick and Ramming Materials • Dolomite • Magnesia • Magnesite • Alumina • Periclase

World's Largest Stripper eliminates ingot stickers

The big 400-ton, push-pull, low head room, screw-type Alliance Stripper Crane is equipped with a stripping mechanism that exerts 2½ million pounds of pressure to smoothly strip moulds from ingots. What's more, a retractable bull nose and gripping tongs enable a single operator to make all necessary adjustments to strip either large end-up or small end-up ingots. These special Alliance-engineered features eliminate stickers, make possible tremendous savings in time, moulds and costly alloy ingots.

Alliance . . . world's largest builder of the world's largest cranes . . . makes a habit of offering industry greater strength and lifting versatility. Our big strippers, built with a name plate rating of 400 tons and overload rating of 1200 tons, embody many other exclusive features of design:

- ★ **Special electrical counterweight (counter torque device) developed by The Alliance Machine Company which prevents ingots from falling and inflicting damage to buggies.**
- ★ **No slack cable during stripping operation.**
- ★ **Eliminates the heavy and hazardous counterweights formerly used.**
- ★ **By means of a unique lubricating device, the ample size bronze nut gives many years of trouble-free service.**
- ★ **Special system of spiral bevel and single helical gears results in smoother operation.**
- ★ **All gears are enclosed and run in oil.**
- ★ **Cab that provides the operator with maximum visibility and safety.**

These and many more features are the reasons why it pays to consult Alliance if you're planning for more, newer and better lifting power for your plant. Write today for an analysis of your specific needs.

THE *Alliance* **MACHINE COMPANY**

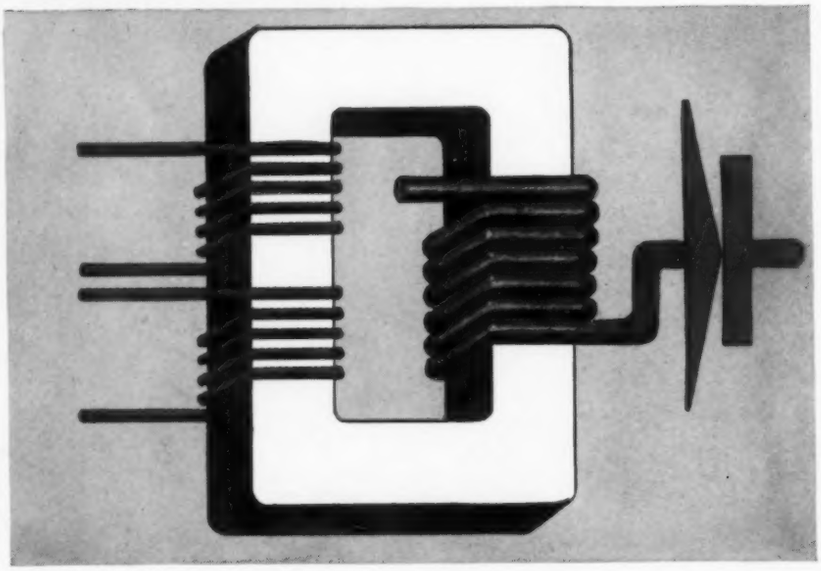
World's largest builders of world's largest cranes

MAIN OFFICE
ALLIANCE, OHIO • PITTSBURGH OFFICE **1622 OLIVER BUILDING, PITTSBURGH, PA.**

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

CLARK *Magnetic Amplifier*

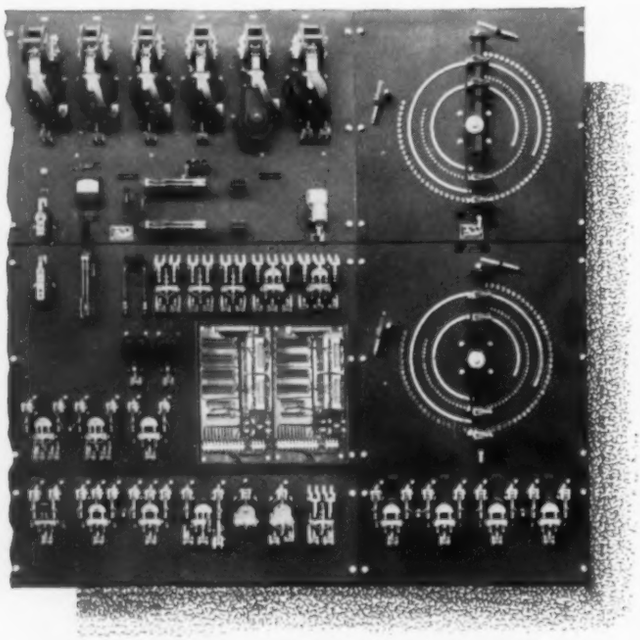
for MILL USE



The CLARK Magnetic Amplifier is particularly adapted for heavy duty mill applications.

Built like a transformer—with no moving parts and no valves, it is unaffected by shock and vibration. It requires no warm-up period, and practically no maintenance. It is rugged and reliable, and does not get out of adjustment.

Its ability to amplify a small signal current makes it ideal for service in voltage regulation, speed control, positioning, tension control and accelerating applications.



The picture shows CLARK Magnetic Amplifiers applied to Motor Operated Rheostats. No contacts are required in the motor circuit to reverse rotation. Pre-selected positions on the rheostats are provided by Push Button and Potentiometer remote control, or combinations of any desired number.

Within a range of 5 to 20 seconds, any selected rate of travel in either direction is available. There is continuous adjustment of position, and the speed of response prevents hunting or overshooting. Accuracy is maintained within one button on the Motor Operated Rheostat.

The power requirement is very low.

Greater production, finer performance and more uniform operation in a broad variety of applications in Steel Mills and other industrial plants result from the use of CLARK MAGNETIC AMPLIFIERS.

Consult CLARK for information regarding practical use of Magnetic Amplifiers in your electrical control operations.

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

BONNOT

INSPECTION TABLE

Greater Steel Production AT LOWER COST PER TON

Whether you have *billets or bars—rods or rails—small slabs or tubes* for inspection in your mill, a Bonnot Inspection Table will give you greater production . . . at lower cost per ton.

Used for any general inspection, or in conjunction with the Bonnot Billeteer, the Hydraulic Inspection Table is another pioneering development (proven in service) of Bonnot engineers that offers these major advantages:

1. assures faster, better inspection because inspector sees 2 faces at one time; he completes all operations from just one position, and with easy wrist motion.
2. enables inspector to work without interfering with Billeteer operator or other billet-cleaning workers and vice versa.
3. increases production because one Inspection Table can keep as many as 6 Billeteers operating at capacity.
4. segregates sizes of raw material so it can be "worked" in practical sequence; production up 15% or more.
5. available for other inspection work involving the quick, accurate and effective handling of heavy material.
6. saves machine time because inspection and marking are done in advance.
7. eliminates need of putting all material through machine; normal practice when pre-machine inspection is not provided.
8. eliminates dangerous, time-consuming hard work of floor inspection.
9. reduces accident hazards, frees storage space for other uses because material is handled more efficiently.
10. speeds "conditioning" by "sorting" material according to work —(a) surfaced completely, (b) flaws or spotting, (c) rejects, (d) no machining.

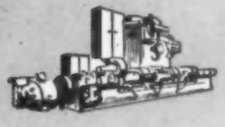
EASY! Inspection and marking flaws in billet—one side; with Bonnot Hydraulic Inspection Table, operator works easily, efficiently, safely.

FAST! Inspection and marking flaws—2 sides and corner at the same time, and within reach of operator without his changing position.

ECONOMICAL! Discharging billet forward after marking. Note unmarked billet (at lower right) awaiting placement for "practically continuous" inspection.

BONNOT WILL "ENGINEER" AN INSPECTION TABLE TO YOUR EXACT NEEDS. WRITE TODAY!

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

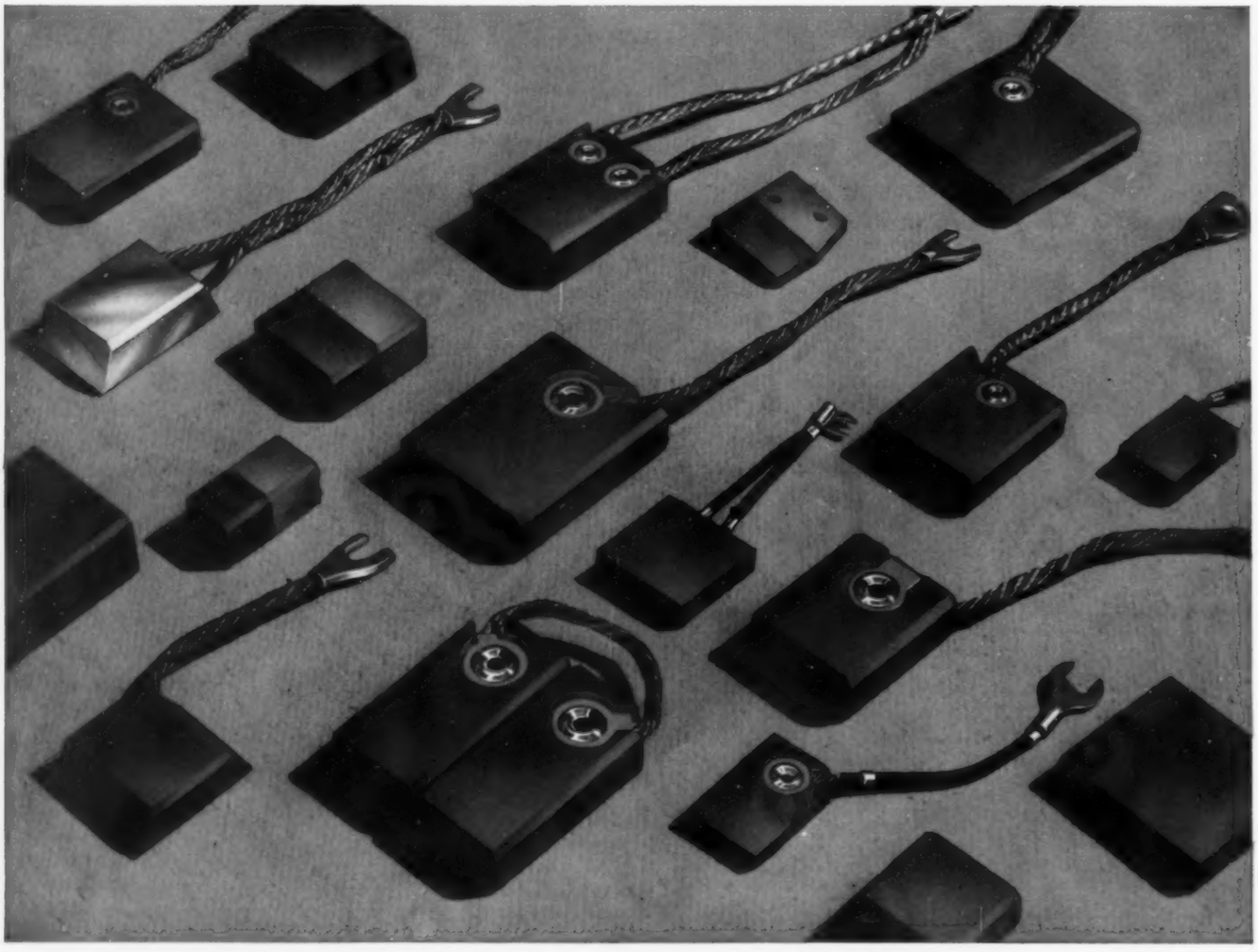
ALSO MANUFACTURERS OF

SAWING · CRUSHING · PULVERIZING & MIXING EQUIPMENT · BILLET INSPECTION TABLES · DUST PUG MILLS · SINTER PLANT PUG MILLS

BUY USG BRUSHES

Try USG Brushes. They will solve those tough application problems for you. • Complete manufacturing facilities, plus continuous research and engineering make USG Brushes and Contacts the best you can use on all rotating electrical equipment. • USG BRUSHES can do a *better* job for you . . . Let us arrange a performance test to prove it.

Write today for 40-page catalog giving complete information on standard USG grades.



90-B

THE UNITED STATES GRAPHITE COMPANY

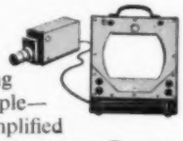
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Announcing...RCA Industrial TV

offering 5 important features

Now RCA offers closed-circuit (wired) television specially designed for all types of industrial applications. By means of this new type of Industrial Television, you can maintain continuous visual checks on remote, inaccessible, or hazardous operations—from one or more points—with clear, high-contrast pictures. RCA Industrial TV has the following five important features.

1. Simplicity



A rugged camera tube (Vidicon)—operating on an entirely new principle—has made possible the simplified RCA Industrial Television system. Camera and monitor are connected by a single cable. No intermediate equipment is necessary. No more tubes than an ordinary home television set. To place in operation, merely connect to 110 volts, 60 cycle AC.

2. Compactness

RCA's new Industrial Television Camera (3" x 5" x 10")—about the size of a 16mm movie camera—weighs only 7½ lbs. Using the Vidicon Tube, this camera is the smallest design available.

3. Ease of Operation

All controls—including those for the camera—are located on the monitor. For fixed operating conditions, once this system is set up, all necessary adjustments can be made with only two knobs . . . operation has been so simplified, anyone can learn to obtain a clear picture in a few minutes.

4. Picture Quality

With an RCA Industrial TV you can obtain high quality pictures without excessive illumination. Scanning frequencies are 525 lines, 30 fields, 60 frames, interlaced . . . the same as standard broadcast television. This permits home television sets to be used as auxiliary viewers.

5. Ease of Service

Carefully engineered simplification of circuits and components has resulted in dependability and ease of service and preventive maintenance. When you buy RCA Industrial Television, you can also buy an RCA Service Plan—complete nation-wide service by trained experts of the RCA Service Company.

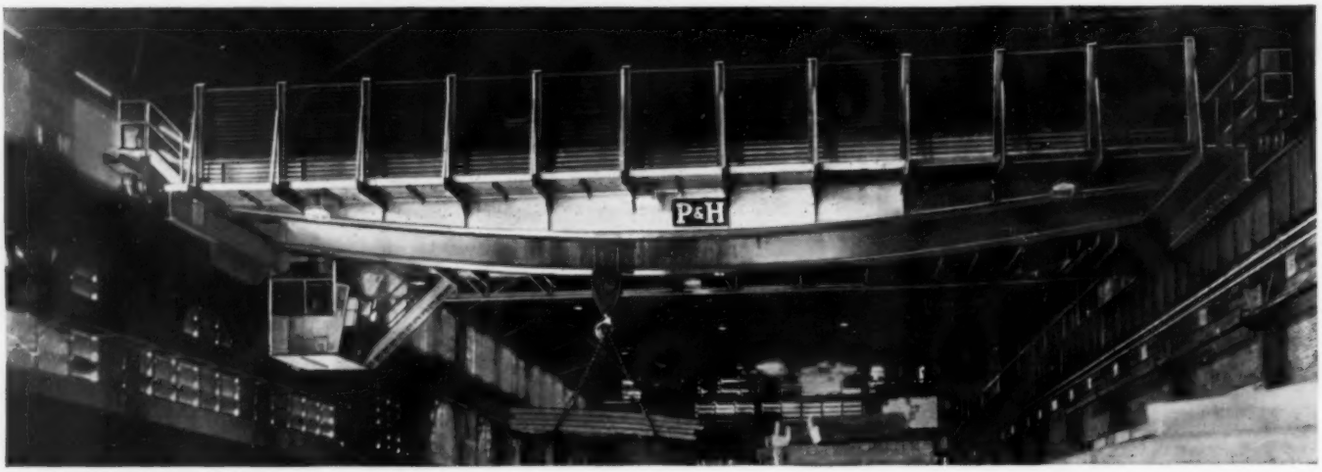
For information on RCA Industrial Television, **ATTACH COUPON TO YOUR LETTERHEAD**

RADIO CORPORATION of AMERICA
INDUSTRIAL EQUIPMENT CAMDEN, N. J.

RCA Industrial Products
Dept 188 L Bldg.-15-7
Camden, New Jersey
In Canada: RCA VICTOR Company, Ltd., Montreal

Please send me information on RCA Industrial Television

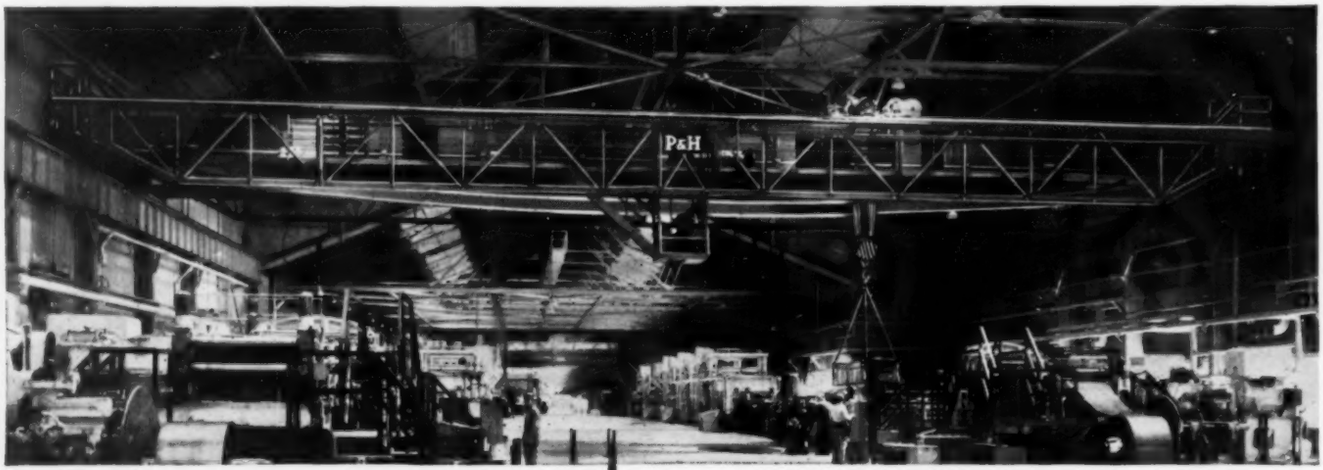
NORTH..SOUTH..EAST..WEST..EVERYWHERE!



P&H

STEEL MEN PREFER
MILL TYPE CRANES
for longer, finer service

Now, the number is well over the 2000 mark — more and more P&H Cranes serving the steel industry. There's good reason for the preference steel men put in P&H . . . and that is *performance*. It's measured in longer years of service, in lower costs, in more dependable operations. Learn more about P&H Mill Type Cranes. Write for your copy of Bulletin C-42.



P&H ***...ahead in added values***

3-Gear Case Bridge Drive — for perfectly equalized motive power.

No Open Gears at Trucks — gear reductions are fully enclosed, running in oil.

Flexible Couplings at Wheel Shafts — for smoother starts, longer bearing life.

Split Gear Cases — easier inspection and maintenance.

Large Diameter Cross Shaft — greater strength, lower torque to minimize strain.

Hoist Sheaves — readily accessible from trolley deck. All hoist gears, including drum gear and pinion, run in oil.

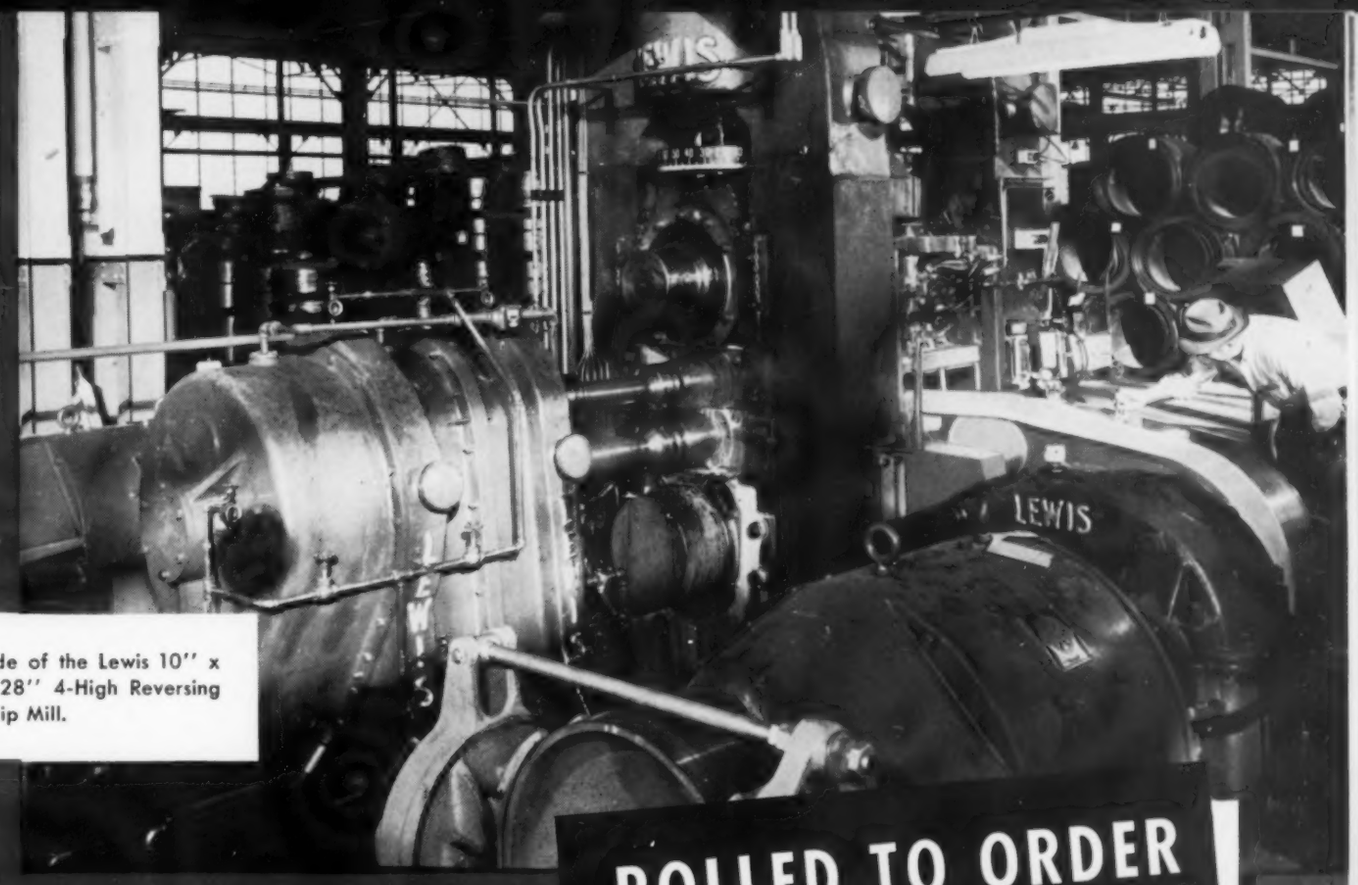
P&H Motors, brakes and controls available.

P&H **OVERHEAD CRANE DIVISION**

HARNISCHFEGER
CORPORATION

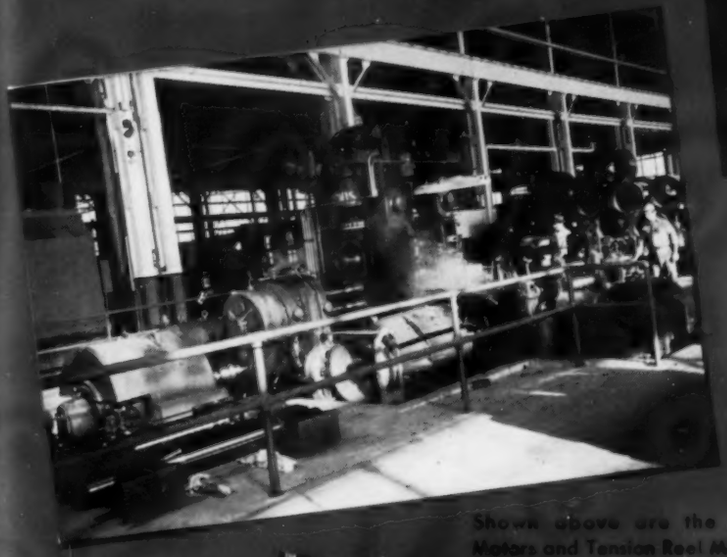
4400 West National Avenue, Milwaukee 46, Wisconsin

POWER SHOVELS • CRAWLER AND TRUCK CRANES • OVERHEAD CRANES • HOISTS • ARC WELDERS AND ELECTRODES • SOIL STABILIZERS • DIESEL ENGINES • PRE-FAB HOMES

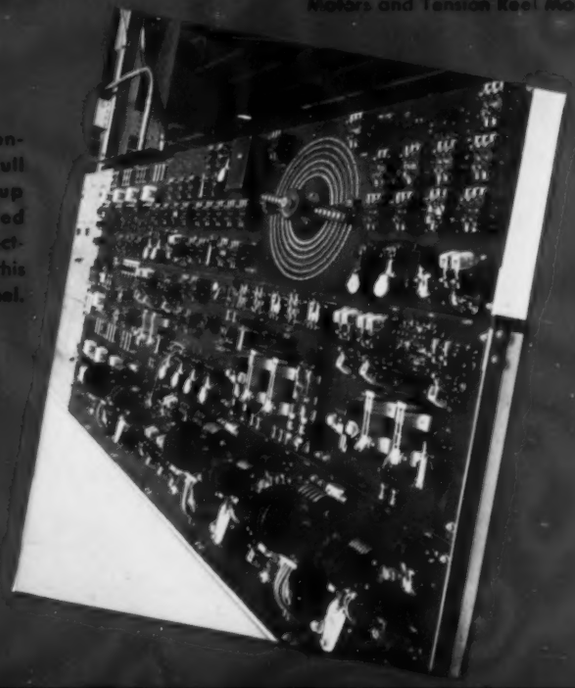


Entry side of the Lewis 10" x 20" x 28" 4-High Reversing Cold Strip Mill.

ROLLED TO ORDER -to Your Specifications



Shown above are the Mill Motors and Tension Reel Motor.



Constant tension over full coil build-up and Mill speed range is effected through this Control Panel.

When Production Steel Coil Co. Inc. gets a request for cold rolled strip of unusual width, gauge, temper and finish, they don't put the customer off with a "not in stock" excuse. They roll the order to exact specifications right in their Detroit warehouse on a Lewis 10" x 20" x 28" 4-High Reversing Cold Strip Mill! Reversing coils permit continuous operation with substantial reductions per pass, and close gauge tolerances are maintained with the most advanced pushbutton controls. This mill, together with its annealing equipment provides an exceedingly flexible arrangement that meets all customers' requirements. Write for complete technical details.

Manufacturers of Rolls and Rolling Mill Equipment For the Iron, Steel and Non-Ferrous Industries

LEWIS

FOUNDRY & MACHINE

Division of Blaw-Knox Company

Pittsburgh, Pa.

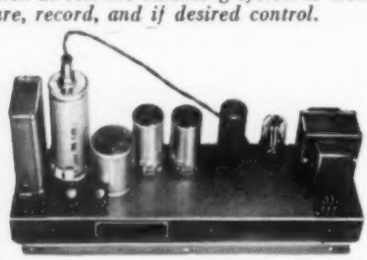
A lot of engineering for a Component!

and every Speedomax user benefits by it!

Converter's job in Speedomax instruments is to receive the (often very small) direct current signal which is related to the temperature, stress pH or other condition being measured, and produce an alternating voltage. This output is amplified, and then directs the balancing system to measure, record, and if desired control.

• The operating precision of the thousands of Speedomax Recorders and Controllers which serve industry and science begins with the engineering of components like this Converter. Our specifications apply at all stages—all the way back to the plants which make metals, insulation materials, etc., for us. These specs represent also the best thinking of our suppliers' engineers. The resulting materials are thus quality-controlled for us—and us alone.

From these materials our engineers tell our factory how to make converter parts to truly tight specifications. Some parts require principally flatness, or elasticity, or dimensional stability. Reeds need correct natural frequency. Many parts of course combine various needs; each gets its requirements.



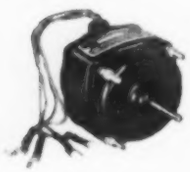
Good engineering shows in this Amplifier's thorough filtering, high impedance, and plug-in connection to the rest of the Speedomax.

Life tests show Fidelity and Stamina. Ingenious and often original design creates from these parts a converter with noise level equivalent to only 0.2 microvolt in an emf potentiometer circuit. And this fidelity promotes accurate measurement and control.

Running on life tests since 1948, present-model converters are today still well inside performance tolerances. Such a run equals 21.9 years of 8-hours-a-day, 200-days-a-year-service—or 1.9 years more than the present age of the first Speedomax.

This kind of engineered performance is also built into the amplifier, slidewire, motor and scores of other exclusively Speedomax parts. It's at your service whether you want to control temperature of steel billets, or record the laboratory studies of steel molecules. Call on L&N application engineers in selecting the exact range (from among thousands) and the exact measuring circuit (from among 2300) to meet your needs. Write our nearest office, or 4942 Stenton Avenue, Philadelphia 44, Pa.

Good engineering shows in this Slidewire's non-inductive winding and in absence of any flexible leads which might form inductive loops.



Good engineering shows in this balancing motor's small size, and in its torque ample to operate accessory control and signalling fitments.

CAREER OPPORTUNITIES AT L&N

Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

LEEDS NORTHRUP

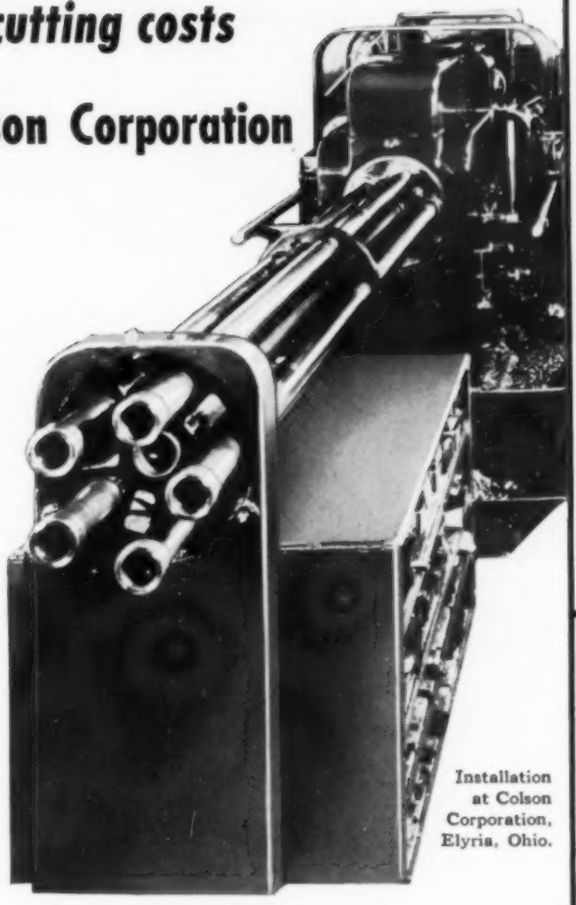
instruments • automatic controls • furnaces

Jrl Ad ND46(6c)

Warner & Swasey Automatics

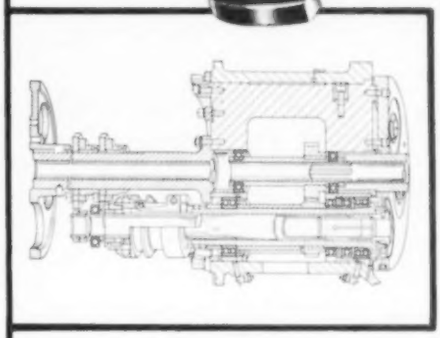
are cutting costs

for Colson Corporation



Installation at Colson Corporation, Elyria, Ohio.

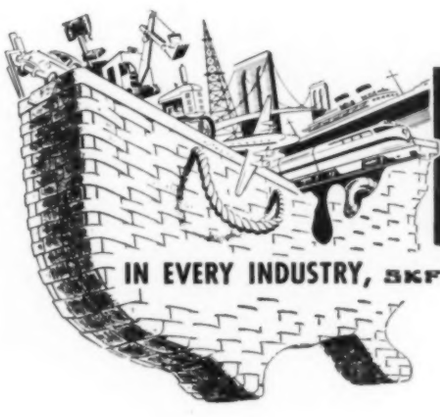
—and their 5-Spindle Automatic Bar Machines are SKF-*equipped*



Here's what Warner & Swasey designers did for one of their customers with advanced 5-spindle automatic bar machines • cut set-up time more than 50% • increased production 7 to 8 times on lots of 500 to 10,000 pieces • made "progressive" set-ups much more practical • made small lots economically practical • provided easy access and interchangeability of tooling • eliminated cam changing.

SKF Double-row Cylindrical Roller Bearings are used on front and rear locations. SKF Ball Thrust Bearings are adjacent to front Bearings. This design gives maximum rigidity through a variety of feeds and speeds without the need of bearing adjustment. Again, the teamwork of machine and bearing designers resulted in advance-designed equipment.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.— *manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.* 7325



SKF®
BALL AND ROLLER BEARINGS

IN EVERY INDUSTRY, SKF Puts The Right Bearing In The Right Place

THE IMPROVED

Exide-Ironclad

BATTERY

GIVES you more...SAVES you more

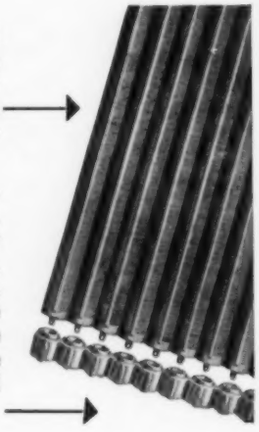
It gives you more of everything that adds up to top performance, long battery life . . . saves you more through low over-all costs. Outstanding new features, including the polyethylene insulating tube sealer, *more than ever before,* make Exide-Ironclad YOUR BEST POWER BUY . . . AT ANY PRICE.

HERE'S WHAT YOU GET

Rapid, accurate handling . . .
Uniform rate of handling . . .
High availability . . . Low operating costs . . .
Low maintenance costs . . . Low depreciation costs . . .
High maneuverability . . . Safe handling

AND HERE'S WHY

IMPROVED POSITIVE PLATE CONSTRUCTION. The long-life grids now contain SILVIUM—an alloy of silver, lead and other components —which make them highly corrosion-resistant.



NEW POLYETHYLENE INSULATING TUBE SEALER of acid-proof, non-corroding plastic. It fits snugly into slotted tubes of positive plates, and reduces loss of active material. Even the small sediment deposit of the past is reduced 50%. Thus more active material remains available, and the high battery capacity is maintained for a longer working life.

PLUS THESE EXTRAS

IMPROVED NEGATIVE PLATES for higher electrical efficiency.

NEW SEALING COMPOUND provides permanent seal between jar and cover.

SEAMLESS SHOCK-PROOF JAR, of high quality rubber, combines tensile strength and elongation for long-life and heavy-duty service.

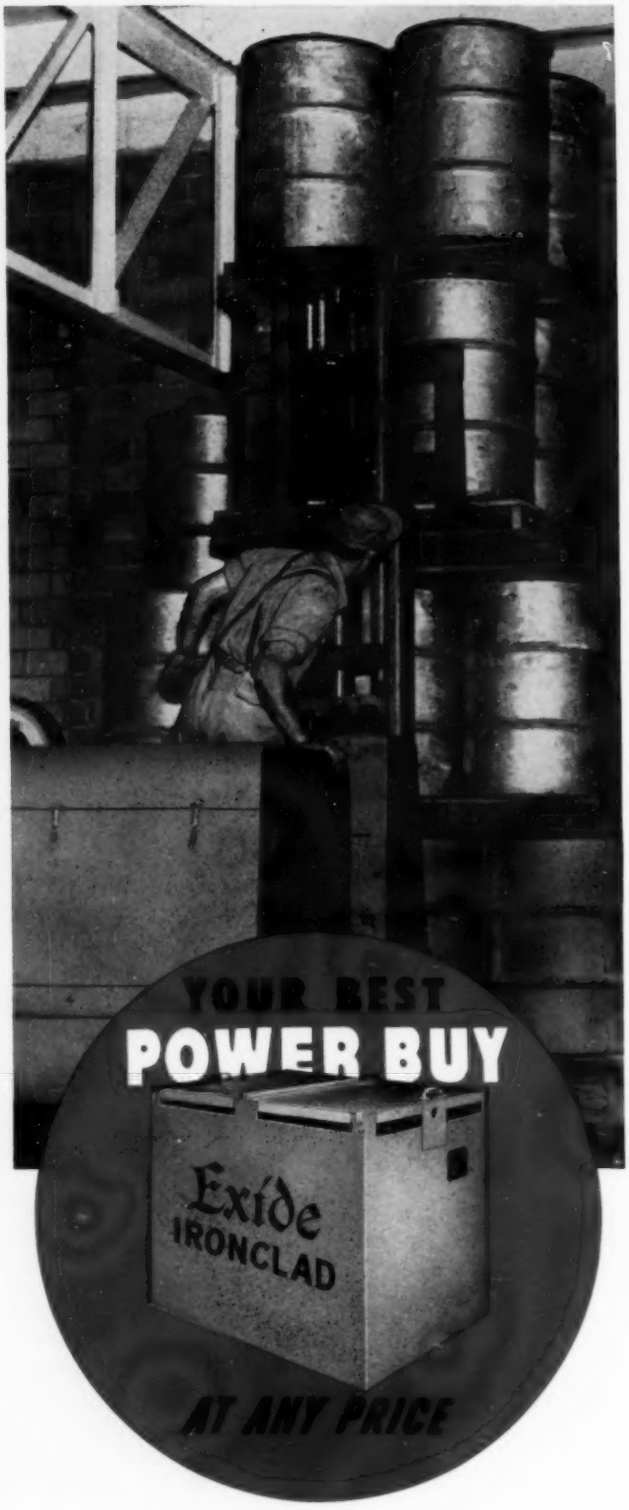
NEW UNBREAKABLE PLASTIC VENT PLUGS of polyethylene.

TYPES, SIZES AND CAPACITIES for all kinds and makes of battery-electric trucks—hand and rider.

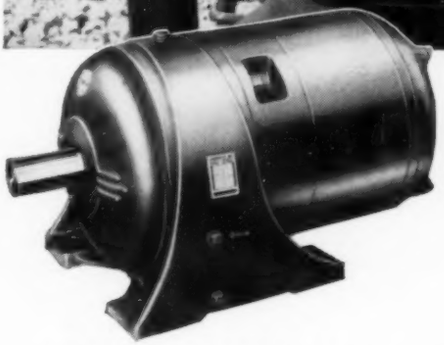
THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia 2
Exide Batteries of Canada, Limited, Toronto

1888
DEPENDABLE BATTERIES FOR 64 YEARS
1952

"EXIDE-IRONCLAD" and "SILVIUM" *Reg. T.M. U.S. Pat. Off.*



FOOTE BROS.-LOUIS ALLIS GEAR-MOTOR installed on Propane input pump for underground storage in a field processing plant.



When the Going's Tough

IT'S FOOTE BROS-LOUIS ALLIS GEARMOTORS FOR SERVICE

Out in the oil fields, there's no time to "baby" equipment. Quality counts and quality must be coupled with the rugged, sturdy ability to stand up under day-in and day-out service.

It is on jobs like these that the inherent stamina — the high quality — of Foote Bros.-Louis Allis Gearmotors prove themselves.

Compact in design, quality built throughout, these gearmotors incorporate Duti-Rated Gears with file-hard surfaces and resilient cores. The cast iron housings give rigidity, and the large oil reservoir with splash lubrication means continuous trouble-free operation.

Foote Bros.-Louis Allis Gearmotors are available in single, double, and triple reductions, to provide output speeds of 780 down to 7.5 r.p.m. and capacities from 1 h.p. through 150 h.p. Open drip-proof, splash-proof, enclosed and explosion-proof motor enclosures are available.

FOOTE BROS.

Better Power Transmission Through Better Gears

LINE-O-POWER DRIVES

HYGRADE DRIVES

MAXI-POWER DRIVES

Foote Bros. Gear and Machine Corporation
Dept. IAS 4545 S. Western Boulevard
Chicago 9, Illinois

Please send me Bulletin GMA containing full information on Foote Bros.-Louis Allis Gearmotors.

Name.....

Company.....

Address.....

Position.....

City..... Zone..... State.....

it takes experience...

Torrington has had many years of experience in the manufacture and application of all types of anti-friction bearings. It knows the advantages of each bearing and the requirements of almost every kind of mechanical equipment. Thus, manufacturers and users of everything from hand tools to rolling mills have learned to rely on Torrington for improved bearing performance.

Next time you have a friction problem, call your nearest Torrington office. They will be glad to help you select the bearing best suited to your application.

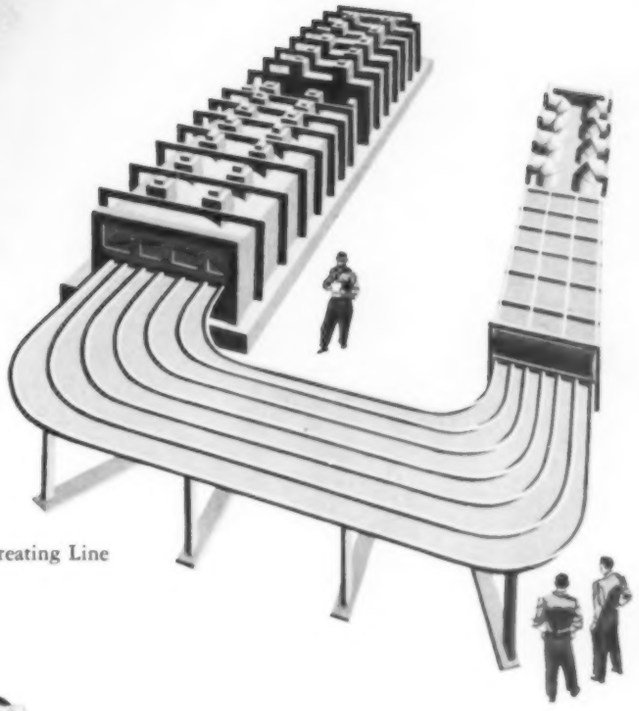
THE TORRINGTON COMPANY
South Bend 21, Ind. Torrington, Conn.
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON BEARINGS

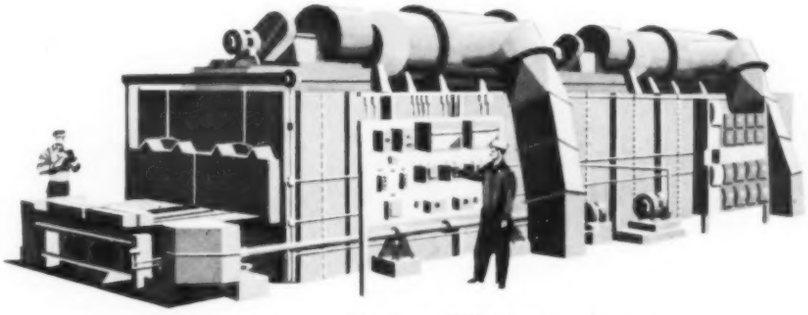
Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers

Specialists in Furnaces for Defense

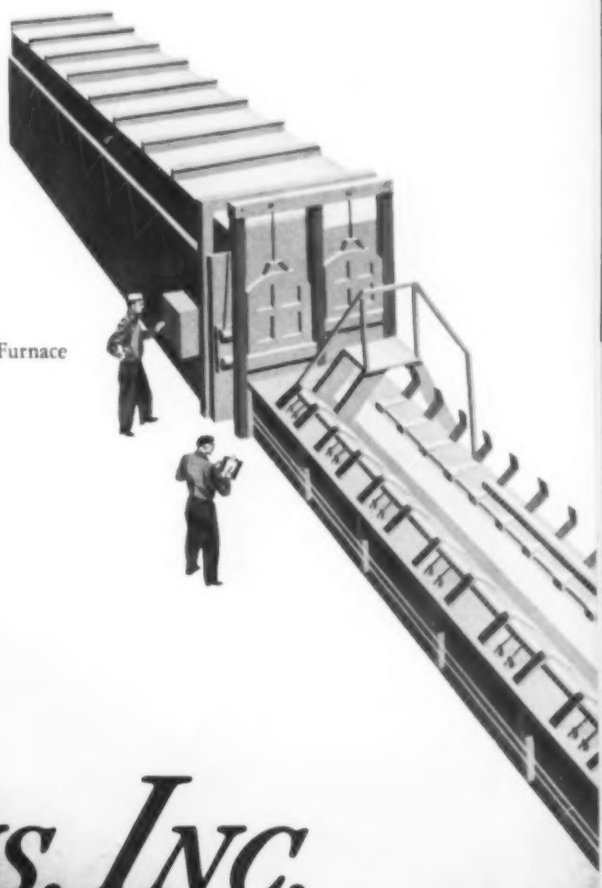
The well-trained and highly-experienced furnace engineers at Salem-Brosius have designed and built a great many eminently successful furnaces for heating and heat treating ordnance and aircraft parts. As a result, they are known as specialists in the field. Though, among them, they have produced just about every type of heavy furnace in use today, they take certain pride in their reputation for producing defense units. It implies some assistance in building America's strength. You'll find that a Salem-Brosius Defense Furnace cuts cost and adds production because it is excellently designed, well constructed, and contains many special features not elsewhere available.



Shell Heat Treating Line



Aluminum Billet Heating Furnace



Gun Barrel Hardening Furnace

Remember, if you have a problem that involves the use of industrial furnaces, blast furnace equipment, or charging and manipulating machines, it will pay you to call on Salem-Brosius today.

SALEM-BROSIUS, INC.

SALES AND EXECUTIVE OFFICES: 248 FOURTH AVENUE, PITTSBURGH 22, PA.

BROSIUS DIVISION, PITTSBURGH 15, PA. SALEM ENGINEERING DIVISION, SALEM, OHIO

DRAVO
DESIGNERS and BUILDERS
BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
WHIRLER CRANES • FLOATING CRANES
DRAVO RAIL CLAMPS • BARGE SHIFTERS
MODERNIZED TROLLEYS FOR EXISTING BRIDGES
BALTIMORE & OHIO RAILROAD's new modern import pier at Curtis Bay in Baltimore has capacity for handling 2000 tons of 200-lb. ore per hour. The two cantilever steel unloading towers and the 895-ft. conveyor system, insure rapid, continuous and economical handling of ore from ship to hopper car.
Why not make use of Dravo's more than 60 years of practical experience in many engineering fields when planning your next heavy material-handling project?
DRAVO
CORPORATION
NEVILLE ISLAND, PITTSBURGH 25, PENNSYLVANIA

STOP RUST! with RUST-OLEUM

See Rust-Oleum Demonstrated Booth 1237

Plant Maintenance Show Cleveland, Ohio

BEAUTIFY AS YOU PROTECT—ALL COLORS, ALUMINUM AND WHITE!

RUST-OLEUM may be applied directly over *rusted surfaces without removing all the rust!* Just remove rust scale and loose particles with wire brush and sharp scrapers . . . then apply by brush, dip, or spray. Costly sandblasting and chemical pre-cleaning are not usually required. Easy as that to cut your maintenance costs. Specify **RUST-OLEUM** to your painting contractor or architect for *every rustable* metal surface! Prompt delivery from Industrial Distributor stocks in principal cities.

RUST-OLEUM CORPORATION
2442 Oakton Street • Evanston, Illinois

RUST-OLEUM STOPS RUST!

FREE SURVEY: A **RUST-OLEUM** specialist will gladly survey your rust problems. He'll make specific tests and recommendations. No cost or obligation. See Sweets for complete catalog and nearest **RUST-OLEUM** distributor, or write for literature on your company letterhead.

Stopping Rust with **RUST-OLEUM** 769 D. P. Red Primer

CLIP THIS TO YOUR LETTERHEAD
MAIL TO: RUST-OLEUM CORPORATION
2442 Oakton Street • Evanston, Illinois

- ☐ Have a Qualified Representative Call
- ☐ Full Details on Free Survey
- ☐ Complete Literature
- ☐ Nearest RUST-OLEUM Source

Look for this label — be sure it's genuine RUST-OLEUM

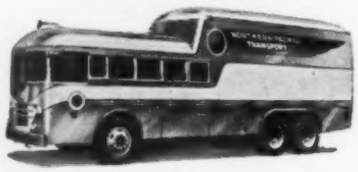
IN ALL INDUSTRIES

LUBRIPLATE LUBRICANTS

EXCEL IN REDUCING FRICTION, WEAR, UPKEEP-COSTS AND POWER-CONSUMPTION...WITH BETTER MACHINE PERFORMANCE

"THIS LUBRICANT CUT OUR PARTS REPLACEMENT 50%"

– says NORTHERN PACIFIC TRANSPORTATION COMPANY



"LUBRIPLATE proved so satisfactory during tests that we installed it in all our worm-gear, hypoid, and two speed axles. This enabled us to change our oil-change period from 15,000 miles to 40,000 and on some applications, depending on speeds and temperatures encountered, we raised the change period to 60,000 miles, or approximately once a year. Our overhaul periods were stretched from 50,000 to 100,000 miles, and repair parts bill cut 50% with the increased mileage."

THE GLOBE COMPANY says:

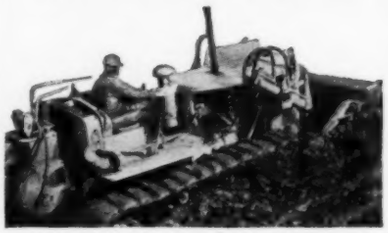
"THIS LUBRICANT INCREASED BEARING LIFE FROM 2 WEEKS TO 2 YEARS"

"After we had quite a few of our large high speed ROTO-CUT meat cutting machines in actual production operation, the ball and spherical roller bearings on the cutter shaft gave us serious trouble due to a condition that prevails throughout the meat packing industry, animal acids and moisture. Some bearings did not last even two weeks. Then, BALL BEARING LUBRIPLATE was called to our attention. The result: these machines lubricated with BALL BEARING LUBRIPLATE have been in continuous operation for over two years without a single bearing replacement.

The Globe Company
Frank J. Bilek (Chief Engineer)

"THIS LUBRICANT kept 'em rolling in mud, muck and water"

– says J. O. ARCHIBALD of Redwood City, California



"Due to our success on similar work, The Leslie Salt Company gave us the contract for the conversion of 500 acres of salt marsh into crystallizing ponds. Knowing from experience that LUBRIPLATE No. 107 reduced friction to a minimum, and prevented rust even in salt water, we adopted it for track and general lubrication. We selected LUBRIPLATE APG-140 for all transmissions and final drives. The effectiveness of LUBRIPLATE is evidenced by the fact that during the entire job there were no replacements of track rollers nor were there any tie-ups of equipment due to replacement or breakage."

J. O. Archibald

REGARDLESS OF TYPE AND SIZE OF YOUR MACHINERY LUBRIPLATE LUBRICANTS IMPROVE OPERATION AND GREATLY REDUCE MAINTENANCE COSTS.

Write today for LUBRIPLATE Data Book No. 1-52

LUBRIPLATE DIVISION
Fiske Brothers Refining Co.
Newark 5, N. J. Toledo 5, Ohio

DEALERS FROM COAST TO COAST—SEE YOUR CLASSIFIED TELEPHONE BOOK

CONTINUOUS WIRE PATENTING, PICKLING AND COATING LINE

by DREVER

Installed in the plant of
John A. Roebling's Sons Company
Trenton, N. J.

Line Consists of

GAS-FIRED, MUFFLE TYPE HEATING FURNACE
GAS-FIRED IMMERSION TUBE HEATED LEAD QUENCHING BATH
COOLING ROLLS
ACID PICKLE TANK
HOT WATER SPRAY RINSE TANK
COATING TANK

CAPACITY, 3000 LBS./HOUR
HIGH CARBON STEEL WIRE
12 STRANDS 0.112" AVERAGE DIA.

Automatic Controls • Can be Electrically Heated
Substantial Savings in Labor Costs
High Quality Products

Send your inquiries and requirements for equipment to our competent staff of engineers and metallurgists

DREVER COMPANY

730 E. VENANGO STREET • PHILADELPHIA 34, PA.

Take it, with our compliments...

this new engineering data book on thermocouples

You need this up-to-the-minute 56-page edition of Bristol's famous book if you're involved with thermocouples and pyrometers of any kind. It's free for the asking. Here's what you get in its three, fact-packed sections . . .

1. You get a User's Manual...filled with data you'll constantly refer to for the right thermocouple and protection tube for every purpose. Included are tables, charts, etc., on Factors Affecting Thermocouple Life, Corrosion and Poisoning, Thermocouple Reproducibility, Proper Location and Installation of Thermocouples, etc.

2. You get a Buyer's Guide...a complete catalog listing assembled thermocouples and replacement parts for all standard installations (special uses, too) . . . with full specifications, prices, illustrations so handily indexed ordering's a cinch.

3. You get Thermocouple Calibration Data ...complete, easy-to-use tables of calibration data for all commonly used base-metal and rare-metal thermocouples.

Make sure you get your free copy now!

BRISTOL

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

THE BRISTOL COMPANY
123 Bristol Road
Waterbury 20, Conn.

Please send free book on Bristol Thermocouple and Pyrometer Accessories.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE_____ STATE_____

HIGHLY RECOMMENDED

for low cost service

CRANE

IRON BODY—WEDGE DISC

Clamp Gate Valves

Crane Wedge Disc Clamp Gate Valves come in OS&Y, inside screw, and quick-opening patterns, all-iron or brass trimmed, screwed or flanged end. Sizes up to 4 in. Working pressures up to 150 psi saturated steam, 225 psi cold service.

Low in first cost, as well as in upkeep . . . and look at their wide utility—

Use Crane Clamp Gate Valves for steam; hot and cold water; crude, fuel, and lubricating oil; air, gas, and gasoline service.

Also in food and chemical process industries for caustic solutions, alkalies, corrosive chemicals, and gases.

You'll find Crane Clamp Gate Valves extra rugged, with a strong reinforced body and husky stem. Their compact design means a better fit for more places . . . a saving on piping in many cases. And because of the simplified clamp construction, these valves enjoy wide favor where frequent cleanout is essential. The bonnet assembly and wedge disc lift out easily—the body stays in the line. Reassembling is no problem for the bonnet joint always makes up tight and stays tight.

Wide choice of regular patterns, all-iron or brass trimmed. On inside screw all-iron valves, an improved self-draining bonnet prevents entrapment of line fluids in the bonnet—protects the threads, keeps the stem working smoothly. Send for Folder AD 1667 or ask your Crane Representative for full details.

The Complete Crane Line Meets All Your Valve Needs. That's Why
More Crane Valves Are Used Than Any Other Make!

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

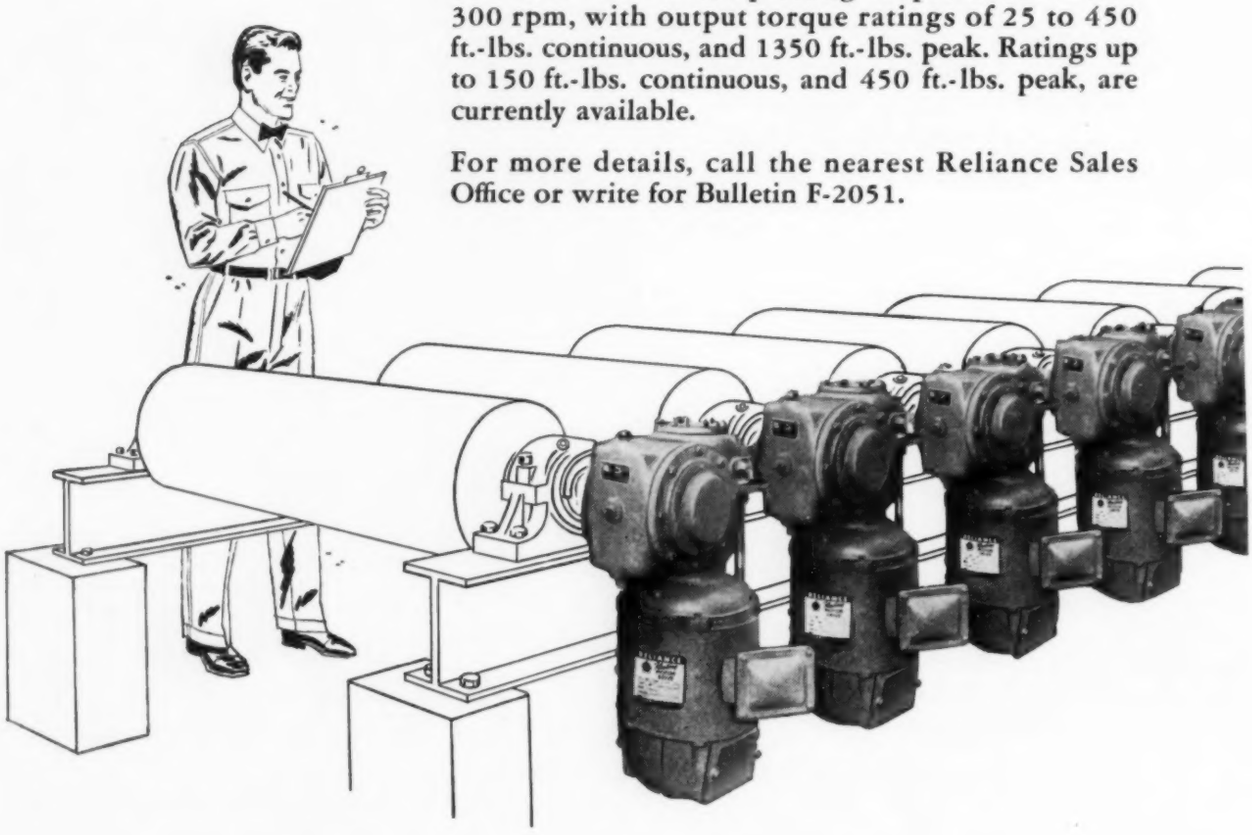
VALVES • FITTINGS • PIPE • PLUMBING • HEATING

NOW... HIGH-TORQUE, LOW-SPEED Trouble-Free Roller-Table Operation WITH RELIANCE Floating Worm Gearmotor Drive

Mounted directly on the roller shaft . . . the Reliance Floating Worm Gearmotor enables roller tables to operate continuously, unaffected by roll warpage or misalignment. External gears and couplings and heavy foundations are no longer required.

The Floating Worm Gearmotor meets requirements for a-c. or d-c. drives operating at speeds from 25 to 300 rpm, with output torque ratings of 25 to 450 ft.-lbs. continuous, and 1350 ft.-lbs. peak. Ratings up to 150 ft.-lbs. continuous, and 450 ft.-lbs. peak, are currently available.

For more details, call the nearest Reliance Sales Office or write for Bulletin F-2051.



RELIANCE ELECTRIC AND ENGINEERING CO.

1084 Ivanhoe Road, Cleveland 10, Ohio • Sales Representatives in Principal Cities

What's the $ Connection?

If there's a furnace operation in your setup . . . there's a mighty big connection between the CITIES SERVICE HEAT PROVER and your profit and loss picture.

Heat Prover—not an instrument you buy, but a service we supply—helps to increase furnace productivity through these five unique advantages:

1. **Rapid, continuous sampling.**
2. **Simultaneous reading of oxygen and combustibles.**
3. **Direct measurement of oxygen and combustibles.**
4. **Easy portability.**
5. **No maintenance; no re-calibration.**

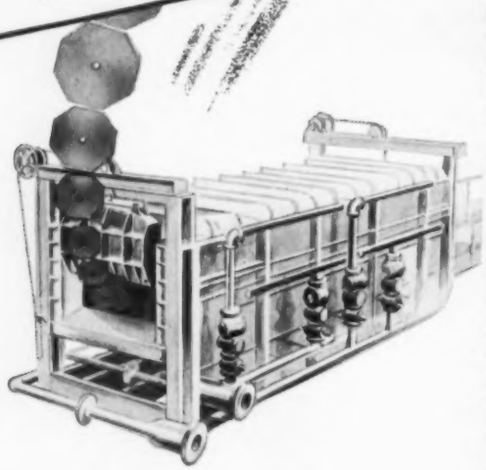
ACCURATE, FAST CITIES SERVICE HEAT PROVER ANALYSIS CAN PUT THE FINGER ON WASTE IN YOUR FURNACE OPERATION. It's being widely used in a great variety of industries. Find out how Heat Prover can serve you. Write Cities Service Oil Company, Dept. L17, Sixty Wall Tower, New York City 5.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

HEATING WHEEL BLANKS TO 2050° F... 100 PER HOUR

INTERMEDIATE STEPS, ROLLING, STAMPING, FORMING.



SELAS Gradiation®

HEATS WHEEL BLANKS AT RATE OF ONE EVERY 36 SECONDS . . . UNIFORMLY WITHOUT SHUTDOWNS

PROBLEM: to uniformly heat the entire surface of octagonal wheel blanks . . . to a rolling temperature of 2050° F. Blank is rolled, from hub to rim, in a series of passes, without reheating, to finish as a uniformly tapered blank. Uneven taper would result in an unbalanced wheel.

SOLUTION: Selas GRADIATION unit designed, developed and built by Selas Engineers. Handles 100 octagonal steel discs 24" across flats and .380" thick per hour. Rotating vertical spindles carry discs horizontally through radiant heat until they reach 2050° F. . . . uniformly and precisely heated. End product is improved at lower unit cost.

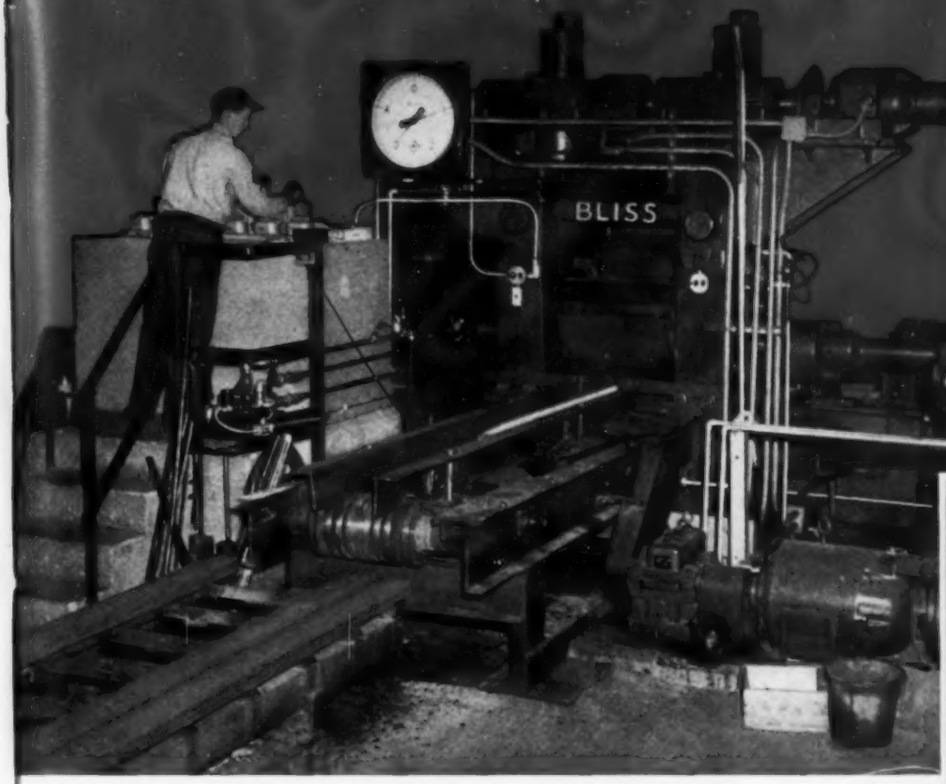
Selas GRADIATION utilizes high intensity radiant gas heat . . . with high temperatures . . . high speed . . . high temperature differential. Heating is uniformly precise, with controlled combustion gases providing protective atmosphere. Where production depends upon heat processing of metals, you can benefit by the experience of Selas engineers. Usually they can provide a new approach to the heating problem . . . through GRADIATION.

SELAS CORPORATION OF AMERICA

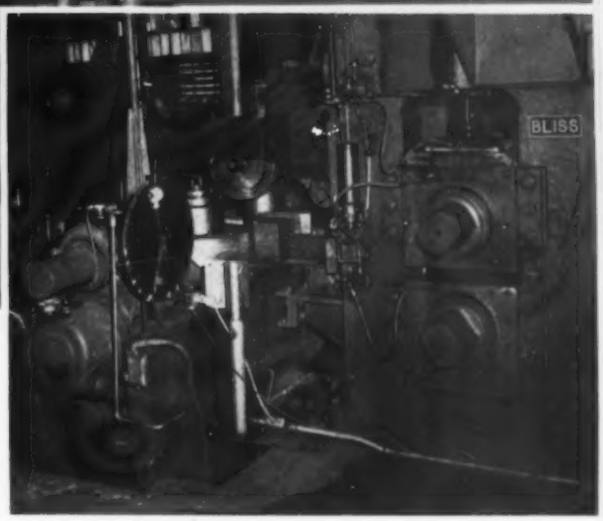
PHILADELPHIA 34, PENNSYLVANIA

Heat Processing Engineers for Industry — Development • Design • Manufacture

Ohio Knife trims rolling time 50% with New BLISS Hot Mill and Edger



Laminated metal, with soft inside core surrounded by hard alloy steels, is hot rolled in this Bliss 19" x 24" Two-High Reversible Mill powered by an AC motor.



Combination of mill, edger and run-out table reduces material-handling manhours by 80%

Proof that the right combination of equipment and methods can contribute startling performance exists at the Ohio Knife Company of Cincinnati. Here, a new Bliss Two-High Mill and Edger hot roll 5" square stock in six passes to 3⅞", holding tolerances within ±0.005". Aside from mill accuracy on daily production runs of as long as 20 hours, Ohio Knife Company officials report that rolling time has been reduced 50%; and material-handling time, 80%.

Recommending designs and methods for efficient metal rolling has been the job of Bliss Rolling Mill Engineers for nearly fifty years. Examples of advanced Bliss mill engineering can be found in many steel, brass, aluminum and specialty plants. Consult Bliss on your next rolling mill equipment problem. And write for our 52-page brochure: "Bliss Mills and Accessories."

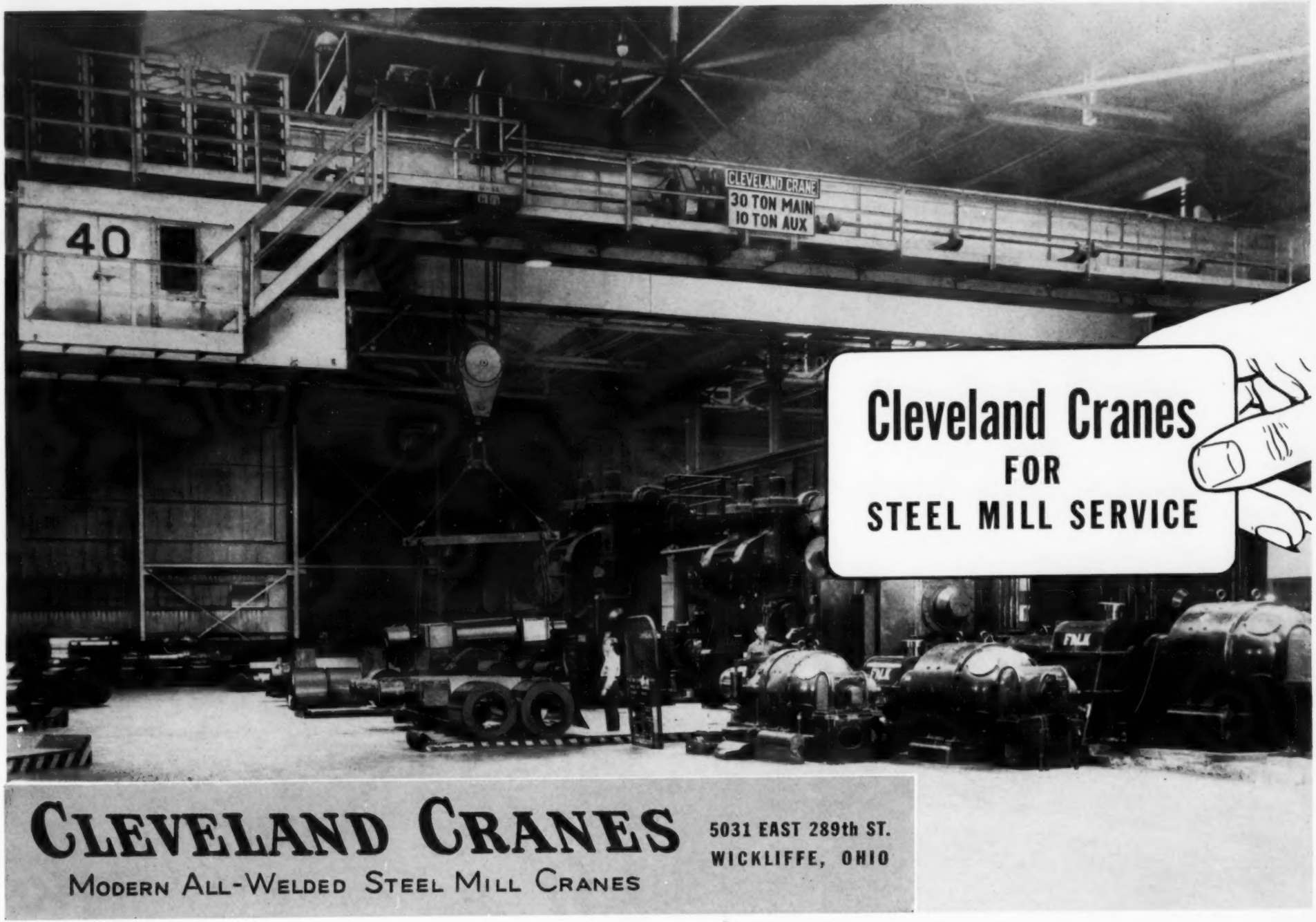
E. W. Bliss Company, General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO
E. W. Bliss (England) Ltd., Derby, England
E. W. Bliss Company (Paris), St. Ouen sur Seine, France

Branch offices in Chicago, Cleveland, Dayton, Detroit, Indianapolis, New Haven, New York, Philadelphia, Rochester, Toledo and Toronto, Canada. **West Coast Representatives:** Moore Machinery Company, Los Angeles and San Francisco; Star Machinery Company, Seattle. **Other dealers** in United States cities and throughout the world.

Remember:

for Presses, ROLLING MILLS, Special Machinery...

It's Bliss


CLEVELAND CRANE
30 TON MAIN
10 TON AUX
40
Cleveland Cranes
FOR
STEEL MILL SERVICE
CLEVELAND CRANES
MODERN ALL-WELDED STEEL MILL CRANES
5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops *and* Shorts

CRYSTAL balls are being worked overtime as economic prognosticators come up with reports of business conditions for the future. The thinking seems to parallel that of late 1949, when some slacking off was felt to be in the offing but failed to materialize when the Korean trouble started. In general, there is agreement that steel production will hold up through the first half of 1953, with a drop-off in the second half. There is no agreement on the degree of the drop, with guesses ranging 75 to 90 per cent of operation. Some longer range predictions show a couple of gloomy 60 per cent years coming, an idea hotly disputed by others.

Perhaps the greatest danger in the gloomy forecasts lies in the possibility that there are a lot of extremists who might take overly pessimistic attitudes in planning their companies' policies. It is an American trait — be it vice or virtue — to swing to both extremes of the pendulum arc. And as AISE president Ike Tull said during a television interview during the recent convention in Cleveland: "If everybody thinks we're going to have a depression, we'll get it."

So let's not worry ourselves into trouble.

▲

BLAST furnaces of the United States set a monthly production record of 6,515,091 net tons of pig iron and ferro alloys in October, according to figures reported by the American Iron and Steel Institute.

▲

WE doubt if the rumor is really true that engineering departments are setting up special estimators to estimate how much the cost of a job will exceed the original estimate.

▲

SPEAKING at the annual meeting of the Marketing Division of the American Petroleum Institute, Admiral Ben Moreell, chairman of Jones & Laughlin Steel Corp., told how far the United States, by majority vote, has progressed along the program of "The Communist Manifesto" as laid out by Karl Marx and Frederick Engels in 1848. The address listed the ten planks of the program and pointed how we have embarked on each of them.

Too long to be reproduced here, Admiral Moreell's talk, "To Communism, Via Majority Vote," should be required reading for every American. It has been reprinted in booklet form and is available upon request to the Public Relations Department, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

▲

ON November 26th, United States Steel Corp. poured the billionth ton of steel made by the company since its organization in 1901. Someone with a water-cooled slide rule figured that this amount of steel would build a bridge with a 22 ft roadway 7.5 times around the earth, make an 18 in. 18 gage band to span the 90,000,000 miles between the earth and the sun, produce a wire to stretch from the earth to Pluto (86,000,000,000 miles away) 13 times up and back, or form a solid steel wall 10 ft high and 52 in. thick around the perimeter of the entire United States.

We'll bet the man-hours required to gather those statistics would have turned out another ton of steel.

▲

AFTER attending the Pittsburgh AISE Christmas party, a friend observed: "A lot of women must be trying to see who can get the most out of an evening gown."

We know what he meant. Low and behold!

▲

A CIRCULAR came to our desk recently setting forth the advantages of having a company's technical publicity handled by the organization that issued the circular. There is no doubt but that such concerns can fill a very real need. However, some of the sales arguments used by a few of the groups in the publicity field are ill-advised and even fallacious.

For example, this most recent leaflet states that technical publicity reaches readers on a high level of editorial prestige, "where no other form of sales promotion can reach." It guarantees a "minimum number of published inches each month," and emphasizes that such a program "usually costs less than a very modest advertising schedule." Other claims include the statements that "publicity gains added prestige when it is prepared by an outside technical publicity firm," and that "the personnel who are placing your material know many of the trade and business publication editors personally."

Actually, good newsworthy items that will interest readers are welcomed by any editor, and they will receive equal consideration whether they come direct from industry, or from independent public relations people, or are written up by the publication's own staff. And if a story is a "stinker," no reputable editor will use it, no matter where it comes from. Friendship is wonderful, but it should not be imposed upon. Poor published material drives away readers, which works to the disadvantage of everyone concerned.

As far as the cost appeal, let's face it. If there were no paid advertising, there would either be no magazines, or they would be prohibitively expensive. If editorial publicity is cheaper, (and this may be questioned) it can only be because advertising is paying the freight.

As we said previously, there is a definite place for some independent technical publicity concerns, but those who make claims such as the foregoing are throwing boomerangs.

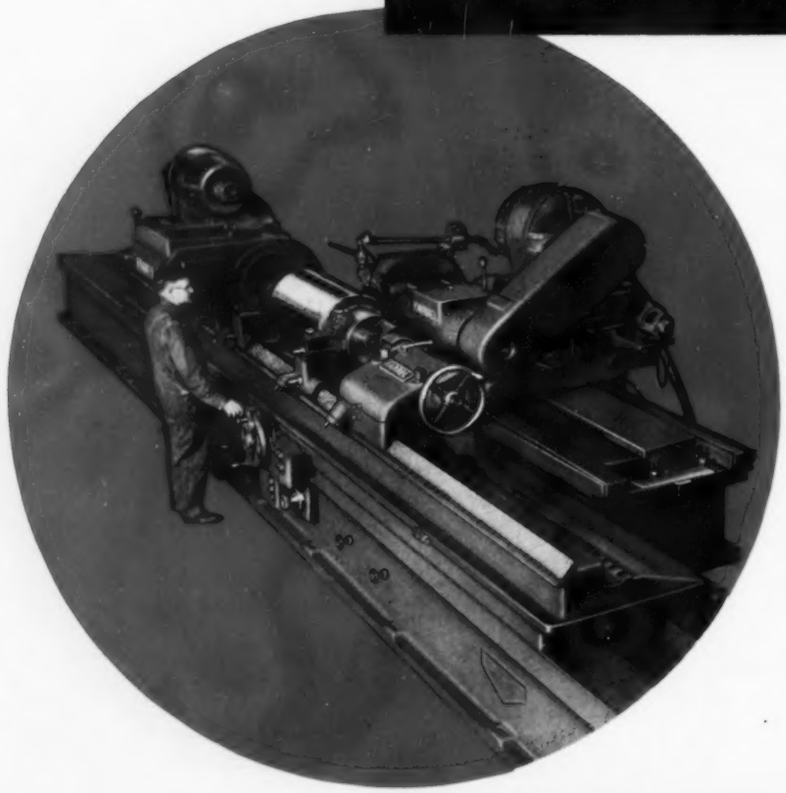
▲

IT doesn't seem possible that we are about ready to wrap up another year, but we can't dispute the calendar. Maybe it's old age creeping up. At any rate — HAPPY HOLIDAYS AND A GOOD NEW YEAR!

FARREL® HEAVY DUTY ROLL GRINDER
Built for heavy roughing or for producing the highest mirror finish it is possible to obtain with wheels at present available. Grinds straight, convex or concave rolls. The crowning device produces a mathematically accurate curve, symmetrical on both halves of the roll, for either a convex or concave shape, without manipulation by the operator. It is easily and quickly set. The same setting invariably produces exactly the same curvature and permits fixed, uniform and easily controlled accuracy of contour in all rolls.

This machine, which has traveling wheel and stationary work, is made in six sizes for maximum roll diameters of 24", 28", 36", 44", 50" and 60", any length required.

CHOOSE YOUR ROLL GRINDER TO SUIT YOUR REQUIREMENTS



FARREL® TYPE TT ROLL GRINDER – This machine has a traveling work table and stationary wheel. Like the heavy duty grinder, it has many automatic features which simplify both setup and operation. Setting-up time is held to a minimum. It also incorporates a number of improvements and refinements which have kept pace with advancing requirements for rolled metal strip and sheet.

The Type TT machine is built in three sizes for maximum diameters of 24", 28" and 32", and any length.

Bulletins giving complete specifications of either of these types of roll grinders will be sent promptly on request.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Pittsburgh, Akron, Chicago, Los Angeles, Houston.

FB-787

Farrel-Birmingham®

"Tycol Armitage boosts bearing life... smooths the way for faster, heavier loads"

Of course! Tycol Armitage Bearing Grease "stays put" ... keeps anti-friction bearings running smooth and cool. Its high stability makes it suitable for sealed anti-friction bearings that must last the life of the equipment.

Tycol Armitage possesses exceptional resistance to oxidation.

The dependable lubricating ability of this quality grease lengthens bearing life and cuts down maintenance costs.

Call your nearest Tide Water Associated office for further information.

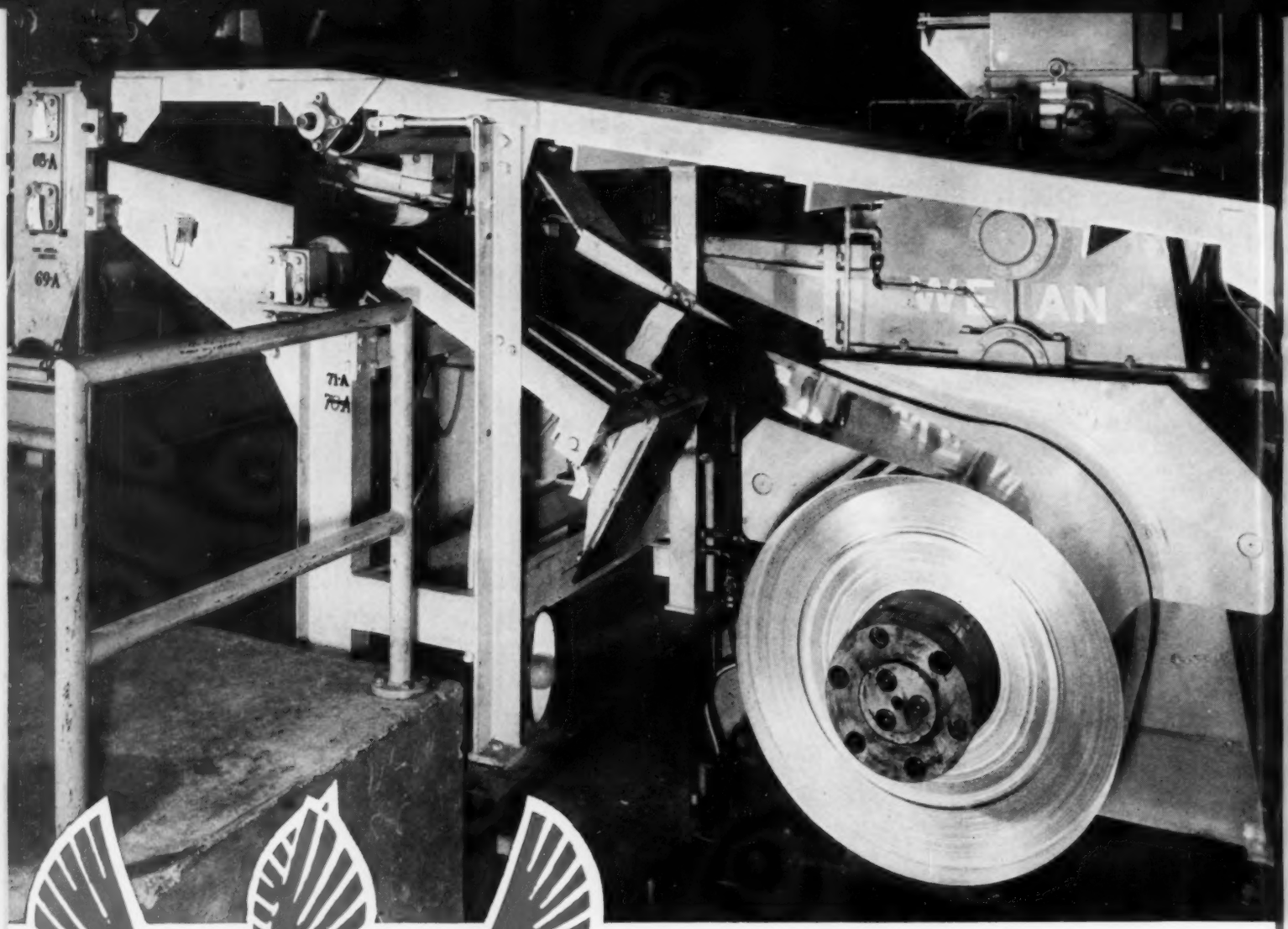
TYCOL

INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C. • Pittsburgh
Philadelphia • Chicago • Detroit
Tulsa • Cleveland • San Francisco

TIDE WATER ASSOCIATED OIL COMPANY

17 BATTERY PLACE · NEW YORK 4, N. Y.



WEAN

electrolytic tinning

The Wean Engineering Company is meeting today's demands for equipment to produce tin plate and zinc coated strip steel with light coatings by the electrolytic method; also equipment to produce chemically treated black plate and strip steel. Equipment for coating strip steel with zinc and other materials by the hot dip method is also available.

The WEAN ENGINEERING COMPANY, INC.

WARREN, OHIO

SPECIALISTS IN SHEET, TIN, AND STRIP MILL EQUIPMENT

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
ALBERT W. ERICKSON, JR., *Production Manager*

Board of Directors

PRESIDENT
I. N. TULL
Electrical Superintendent
Republic Steel Corp.
Cleveland, Ohio

FIRST VICE PRESIDENT, JOHN L. YOUNG, *Vice President — Engineering,* United States Steel Co., Pittsburgh, Pa.

SECOND VICE PRESIDENT, E. L. ANDERSON, *Electrical Superintendent,* Bethlehem Steel Co., Johnstown, Pa.

TREASURER, JOHN H. VOHR, *General Superintendent,* Gary Works, United States Steel Co., Gary, Ind.

SECRETARY, W. H. COLLISON, *Assistant General Superintendent,* Blast Furnace Division, Great Lakes Steel Corp., Ecorse, Mich.

PAST PRESIDENTS: C. H. WILLIAMS, *Assistant Executive Vice President Engineering and Raw Materials,* United States Steel Co., Pittsburgh, Pa.

A. S. GLOSSBRENNER, *Vice President Operations,* Youngstown Sheet and Tube Co., Youngstown, Ohio.

HONORARY DIRECTORS: JAMES FARRINGTON, *Special Assistant to Chief Plant Engineer,* Wheeling Steel Corp., Steubenville, Ohio.

CHARLES L. McGRANAHAN, *Technical Assistant to Works Manager,* SOLLAC, Seremange (Moselle), France.

L. F. COFFIN, *Assistant General Manager,* Bethlehem Steel Co., Sparrows Point, Md.

DIRECTOR-AT-LARGE: JAMES D. O'ROARK, *Assistant to Manager of Service—Maintenance,* Weirton Steel Co., Weirton, W. Va.

DIRECTORS: B. C. BLAKE, *Vice President and General Manager,* Connors Steel Co., Birmingham, Ala.

W. G. SMITH, *Assistant General Manager,* Bethlehem Steel Co., Lackawanna, N. Y.

R. W. HOLMAN, *Division Superintendent of Maintenance,* Sheet & Tin Mills, United States Steel Co., Gary, Ind.

LEONARD LARSON, *Chief Engineer,* Republic Steel Corp., Cleveland, Ohio.

WILLIAM J. REILLY, *General Production Manager,* Ford Motor Co., Dearborn, Mich.

R. W. COUCH, *Superintendent of Saucon Mills and Shipping Yards, Saucon Division,* Bethlehem Steel Co., Bethlehem, Pa.

A. G. ERICSON, *Chief Engineer, Homestead Works* United States Steel Co., Munhall, Pa.

R. W. GRAHAM, *Superintendent, Electrical Department,* Bethlehem Steel Co., Lackawanna, N. Y.

E. A. HAWK, *Fuel Engineer,* Tennessee Coal & Iron Division, United States Steel Co., Ensley, Ala.

A. K. BLOUGH, *Superintendent, No. 2 and 3 Melt Shops,* Republic Steel Corp., Canton, Ohio.

J. N. IMEL, *Superintendent, Continuous Strip and Sheet Department,* Jones and Laughlin Steel Corp., Pittsburgh, Pa.

JAMES J. HEALY, *Project Engineer,* Armco Steel Corp., Middletown, Ohio.

D. N. EVANS, *Assistant Master Mechanic,* Inland Steel Co., East Chicago, Ind.

Managing Director
T. J. ESS
Empire Building
Pittsburgh, Pa.

Iron AND Steel ENGINEER

DECEMBER, 1952 VOLUME XXIX NUMBER XII

In This Issue

Investigation of the Piercing Process by Means of Model Wax Billets — By J. L. Holmquist, Director of Research, Spang-Chalfant Division, National Supply Co., Ambridge, Pa. 53
Developments in Electrical Drives for Steel Mill Applications — By W. R. Harris, Manager Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa. 69
Injection of Oxygen-Reformed Natural Gas and Fuel Oil Into the Blast Furnace — By Dr. Julien O. Raick, Ingenieur Civil des Mines, A.I.Lg., Brussels, Belgium and James E. Brassert, Executive Vice President, H. A. Brassert & Co., Inc., New York, N. Y. 75
Selection and Analysis of Regulating Systems for Mill Drives — By W. E. Miller, Manager, Steel Mill Section, Industrial Engineering Dept., and F. S. Rothe, Manager, Control Systems Section, Analytical Engineering Dept., General Electric Co., Schenectady, N. Y. 81
Operative Results of One-Way Fired Recuperative Soaking Pits — By E. H. Cauger, Chief Combustion Engineer and J. C. Stamm, Jr., Field Engineer, Wheeling Steel Corp., Steubenville, Ohio 98
How to Select a Hoist for the Job — By C. O. Barnes, Sales Manager, Hoist Div., Harnischfeger Corp., Milwaukee, Wis. 111
Heating up Open Hearth Furnaces After Rebuilding — By Hobert M. Kraner, Ceramic Engineer, Research Dept., and Charles N. Jewart, Ceramic Engineer, Lackawanna Plant, Bethlehem Steel Co., Lackawanna, N. Y. 113
Planned Maintenance of Blooming Mills — By H. F. Jacquart, Master Mechanic, Blooming Mills Dept., Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa. 118
Current AISE District Section Meeting Notices 121
Some Experiences with Air Pollution Abatement in the Steel Industry — By C. A. Bishop, Research Associate, United States Steel Co., Pittsburgh, Pa. 122
Plate Qualities Required in Can Manufacturing — By S. L. Flugge, Research Dept., Continental Can Co., Inc., Chicago, Ill. 127
AISE Standard No. 12, D-C Mill Motor Brake Standards 131
Report on AISE Mill Motor Brake Standardization — By V. E. Schlossberg, Chairman, Mill Motor Brake Standardization Committee 133
Hydraulic Roll Lathe Reduces Roll Dressing Time 136
Timken Replaces Open Hearths with Electric Furnaces 139
Bloom Engineering Company Expands for Better Customer Service 149
Applications for AISE Membership 152
Date-Line Diary 155
Industry News 171
Personnel News 193
Publication Service 205
Equipment News 211
Iron and Steel Engineer Index for 1952 219
Index to Advertisers 231

Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expressions of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility.

Copyright, 1952 The Association of Iron and Steel Engineers.

Indexed by Engineering Index and by Industrial Arts Index.

Single Copy Foreign Prepaid $2.00 Single Copy $1.50
Subscription price in U. S. and Canada (U. S. funds) ..... $ 7.50 per year
Subscription price in foreign countries ..... $10.00 per year

PLASTIC BINDING U. S. PATENT NO. 1973285 LICENCE NO. 139.

Lectromelt
RAISED THE ROOF
and electric arc melting COSTS CAME DOWN

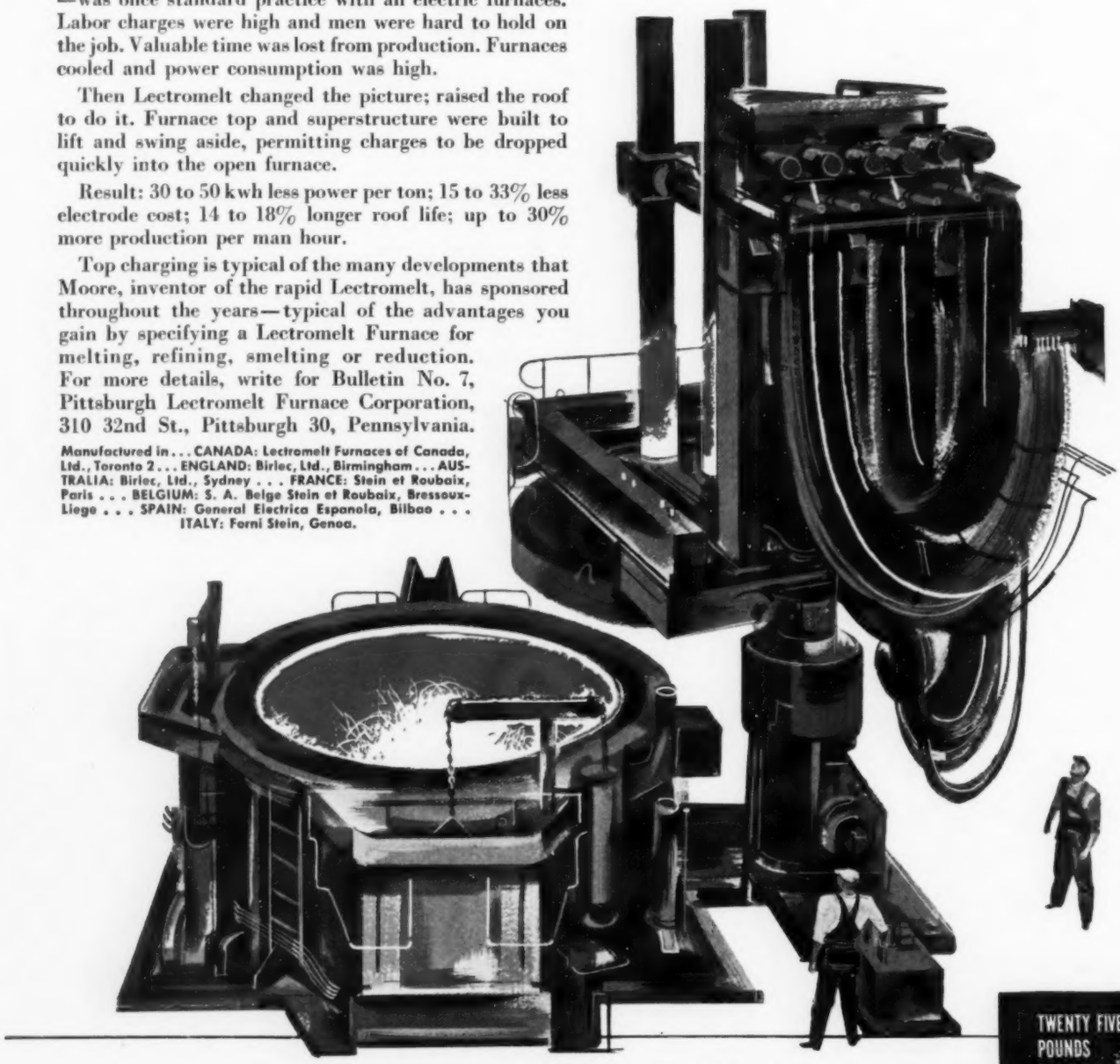
Machine charging—shoveling materials through the door—was once standard practice with all electric furnaces. Labor charges were high and men were hard to hold on the job. Valuable time was lost from production. Furnaces cooled and power consumption was high.

Then Lectromelt changed the picture; raised the roof to do it. Furnace top and superstructure were built to lift and swing aside, permitting charges to be dropped quickly into the open furnace.

Result: 30 to 50 kwh less power per ton; 15 to 33% less electrode cost; 14 to 18% longer roof life; up to 30% more production per man hour.

Top charging is typical of the many developments that Moore, inventor of the rapid Lectromelt, has sponsored throughout the years—typical of the advantages you gain by specifying a Lectromelt Furnace for melting, refining, smelting or reduction. For more details, write for Bulletin No. 7, Pittsburgh Lectromelt Furnace Corporation, 310 32nd St., Pittsburgh 30, Pennsylvania.

Manufactured in . . . CANADA: Lectromelt Furnaces of Canada, Ltd., Toronto 2 . . . ENGLAND: Birlec, Ltd., Birmingham . . . AUSTRALIA: Birlec, Ltd., Sydney . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege . . . SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein, Genoa.



WHEN YOU MELT... MOORE RAPID *Lectromelt*

INVESTIGATION OF THE PIERCING PROCESS BY MEANS OF MODEL WAX BILLETS

By J. L. HOLMQUIST
Director of Research
Spang-Chalfant Division
National Supply Co.
Ambridge, Pa.

. . . . the model wax billet method can be used in the laboratory to determine the metal flow in the tube piercing operation . . . .

▲ THE investigation covered by this report was undertaken for the general purpose of learning as much as possible about the displacement and deformation of material which occurs when a solid round billet is converted to a hollow cylinder or "shell" by a Mannesmann type piercing mill. The present report is mainly a description of the experimental technique and apparatus which has been developed. The technique has been applied so far to only one of many specific problems which could be selected for investigation—namely, the effect of the rate of reduction of section area on the magnitude and distribution of the deformations which occur in the piercing operation.

In this investigation, the wax billets used were 1-⅝ in. diam by 6 in. long. Two types of billet have been used as shown in Figure 1. Billet A contains filaments of colored wax running throughout its length parallel to the axis of the billet. The filaments are positioned along radii of the billet and are so spaced as to mark off the radius into six equal segments. Billet B contains a mid-section in which wafers of different color wax alternate. The colored filaments and colored wafers give evidence as to the displacement and deformation which occurs in piercing.

WAX COMPOSITION AND BILLET MAKING TECHNIQUE

A number of wax compositions were tried and the following composition was adopted as most generally satisfactory:

	Per cent
Carnauba wax	8 by weight
Ceresin	40 by weight
Paraffin	44 by weight
Beeswax	8 by weight
	100

Zinc oxide: 10 per cent by weight added to above composition.

The bulk of the wax composition consists of ceresin and paraffin, ceresin being added to raise the softening temperature. The carnauba wax is added for increased hardness at room temperature. Beeswax reduces the "slipperiness" of the composition so that there is less tendency for the rolls to slip on the billet in piercing. The zinc oxide was added as an opacifier but probably also contributes to the reduction of "slipperiness." The wax composition was chosen with regard to its behavior in the piercing operation and also with regard to its casting properties, since the billets are made by a casting process. The billets are heated to 115 F for piercing.

The colored wax filaments have the same composi-

Figure 1 — Types of wax billets used in piercing experiments.

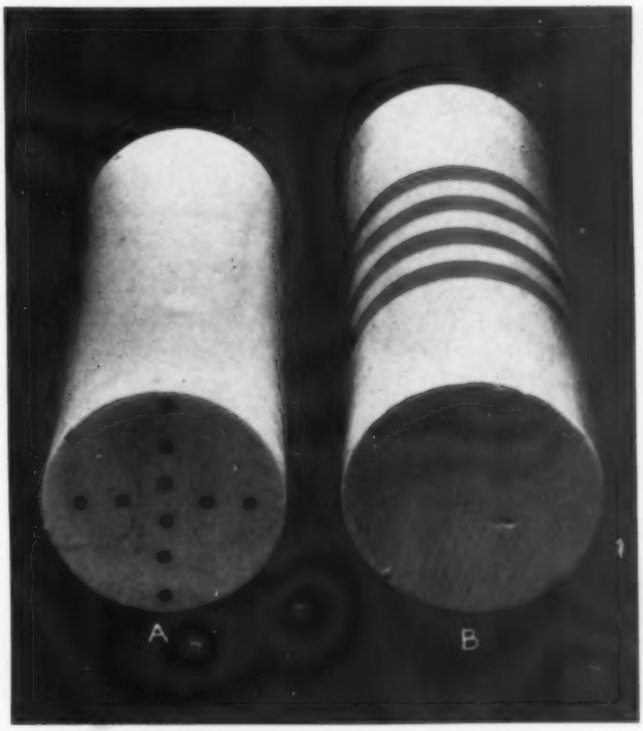


Figure 2 — Apparatus used for casting wax billets containing colored wax filaments.

tion as the remainder of the billet except a small amount of an oil-soluble dye, toluidine red, is added.

The apparatus used for making billets with longitudinal filaments is shown in Figure 2. A cylindrical mold A is assembled with the top and bottom caps B. These caps have holes drilled in them through which $\frac{3}{32}$-in. drill rods are inserted. The molten wax is poured through a hole in the top cap. As the wax solidifies, more molten wax is added to prevent formation of pipe due to shrinkage. When the wax has solidified, the drill rods are pulled out with pliers. The billet is then removed from the mold.

The procedure for filling the channels left by withdrawal of the rods is as follows: A stool D (Figure 2) contains a center cavity into which is poured a small quantity of molten wax to which the dye has been added. The bottom end of the billet is forced into a tight-fitting steel sleeve which in turn fits closely into the cavity in the stool. The billet with attached bottom sleeve is then worked up and down in the stool cavity by hand with the result that the molten wax in the cavity is forced upward through the channels in the billet. Another tight fitting sleeve E is placed on the top of the billet to retain the wax forced out at the top end. Reciprocating the billet and attached sleeve in the stool cavity causes the molten wax to flow back and forth through the channels left by withdrawal of the rods so that air bubbles are worked out and the molten thoroughly wets the walls of the channels. When the molten wax in the channels solidifies, the resulting filaments are firmly welded to the matrix so that, except for the difference in color of the wax in the filaments, a homogeneous billet is obtained.

The wafer type of billet is made by welding discs of wax together by means of a hot wire. A fine wire heated by electric current is passed slowly through the interface between two discs pressed together. As the wire slowly traverses across the interface, the wax ahead of the wire melts and the wax behind the wire freezes so that when the traverse is completed the discs have been fusion welded together.

THE PIERCING MILL

A model piercing mill has been built for piercing the model wax billets. The mill is patterned after production equipment in all essential respects.

Figure 3 shows a general view of the piercing mill. The rolls are 9 in. in diameter so that the mill is to approximately one-quarter scale as compared to a 36 in. piercing mill.

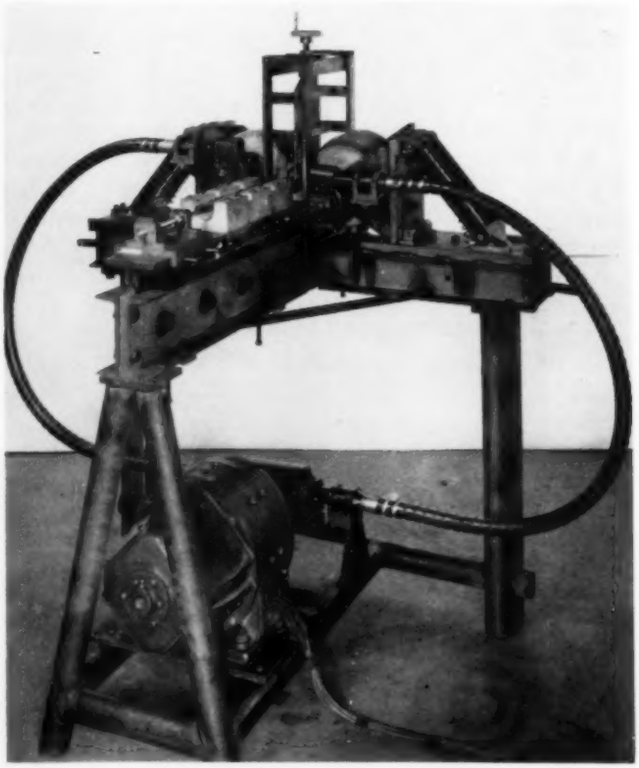
It will be noted that the rolls are driven by worm gears through flexible shafting from the motor. A one-horsepower variable speed motor is used which gives any desired roll speed from about 22 to 88 rpm.

The rolls, shoes, outlet guides and piercer points are made from hard maple wood. This material is entirely satisfactory for these parts due to the low piercing temperature of the wax.

The roll obliquity angle can be varied from zero to 15 degrees. The adjustment of draft and shoes is by means of screws. The rolls were made somewhat longer in proportion to their diameter than in the production mill. This was done to permit more latitude in experimenting with small obliquity angles than is available on the production mill.

A special feature is a quick release mechanism to permit the stoppage of the piercing operation at any desired point. The roll carriers are hinged so that the rolls can be swung outward away from the billet by springs when a latch mechanism is tripped. This feature also has the advantage of permitting the rolls to be moved

Figure 3 — View of model piercing mill from outlet end.



away from the shoes and makes the shoes more easily accessible for adjustment or replacement. Figure 4 shows the hinged construction of the roll carriers.

The model mill was designed to be highly flexible in adjustment and settings and to be as "open" as possible. The open construction was desired for better visibility of the working parts during operation.

TYPES OF DEFORMATIONS OCCURRING IN THE PIERCING PROCESS

In the piercing of a billet certain deformations occur which are essential to the change in shape from the solid round to the hollow cylinder. In addition to these, other deformations are found to occur which are unessential to the conversion of solid round into hollow cylinder. The essential deformations will be called the "basic" deformations and the unessential deformations will be called "redundant" deformations.

What is here meant by "basic deformations" can be illustrated with the aid of Figure 5. Figure 5A represents an end view of a billet which is imagined to be composed of a series of nested shell elements, 1, 2, 3, 4, 5. The billet is of length l which is increased to length L by piercing. For simplicity it is assumed that, after piercing, the outside diameter of the resulting hollow cylinder is the same as the original billet. The chief deformation of shell 1 is simply the increase in length. But the volume of material in the shell is the same before and after piercing, and the cross-sectional area of shell 1 is therefore reduced by the ratio l/L when the billet is pierced. The inside diameter corresponding to the reduced cross section area is readily calculated, and it becomes the outside diameter of shell 2 after piercing. Shell 2 is also increased to length L but, in addition, its outside diameter is increased; both of these dimensional changes act to reduce the wall thickness of shell 2 by the piercing operation, and the reduction in wall thickness is accordingly greater than in shell 1. All the shells are stretched to the same final length L, but progressing inwardly the increase in diameter and reduction in wall thickness becomes greater for each shell than for the preceding one until the maximum is attained at the innermost shell.

Figure 5B shows the shell elements in the billet after piercing, corresponding to the shell elements in the original billet shown in Figure 5A. In this description it is, of course, a matter of arbitrary choice how many elements the original billet is divided into and the wall thickness of each, but whatever pattern is used in the original billet, it can be transposed into the corresponding pattern after piercing.

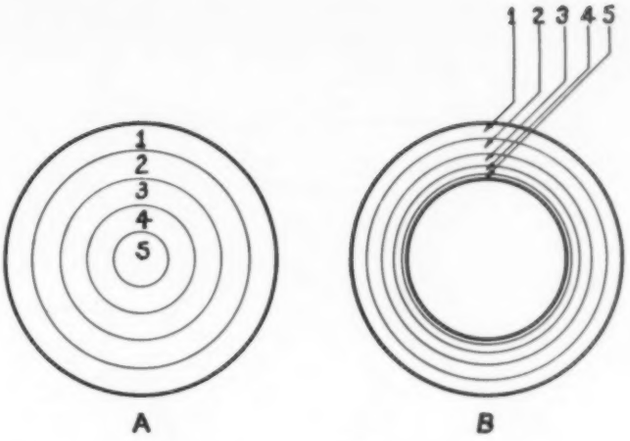


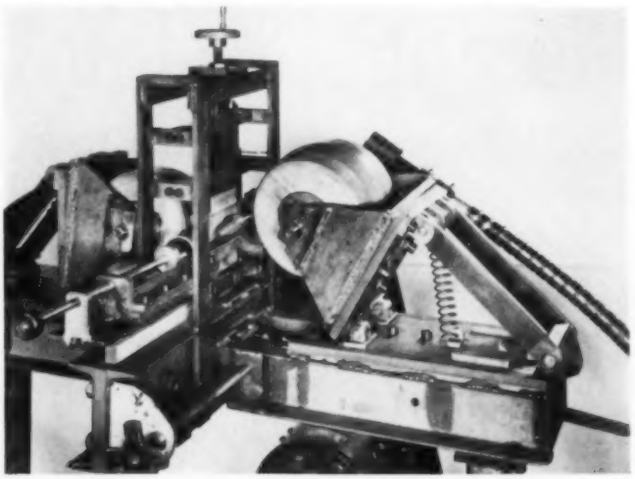
Figure 5 — Shell elements 1 to 5 in billet A correspond to shell elements 1 to 5 in pierced billet B.

Each shell is subject to three principal plastic strains: a longitudinal strain which is the same for all shells, a tangential strain (circumferential stretch due to increase in diameter), and a radial strain (corresponding to reduction in wall thickness). These three principal plastic strains are the basic deformations. The foregoing description may seem unnecessarily detailed; however, the writer feels this description to be a helpful introduction to the following generalization: The basic deformations are determined solely by geometrical relations; a certain size billet pierced into a hollow cylinder of given outside diameter and wall thickness is subject to basic deformations whose magnitude and distribution are governed solely by the relations between these dimensions. This being true, the material of the billet has no influence; the basic deformations must be the same whether the billet is wax or steel. Also, since the basic deformations are governed solely by geometric relations, the method of piercing has no influence on the basic deformations; they are the same whether the billet is pierced by a Mannesmann mill or a hydraulic press.

In the foregoing description it has been stated that the longitudinal strain is the same across the wall thickness of the pierced billet. This is true for the *overall* operation, but transiently at the position where the piercer point is opening up the hole in the billet, it is not necessarily the case. It has been observed in the wax billets that material near the center of the billet may first undergo a longitudinal compression, or shortening, where it comes into contact with the tip of the piercer point. The different deformations which occur can and do progress at different rates along the cavity in the billet corresponding to the contour of the piercer point.

By use of the simple theory of the basic deformations, the change, due to piercing, in the position, size and shape of the longitudinal filaments in the type A billets can be readily predicted. The procedure is illustrated in the Appendix.

Figure 4 — This view of model piercing mill shows construction of roll carriers.



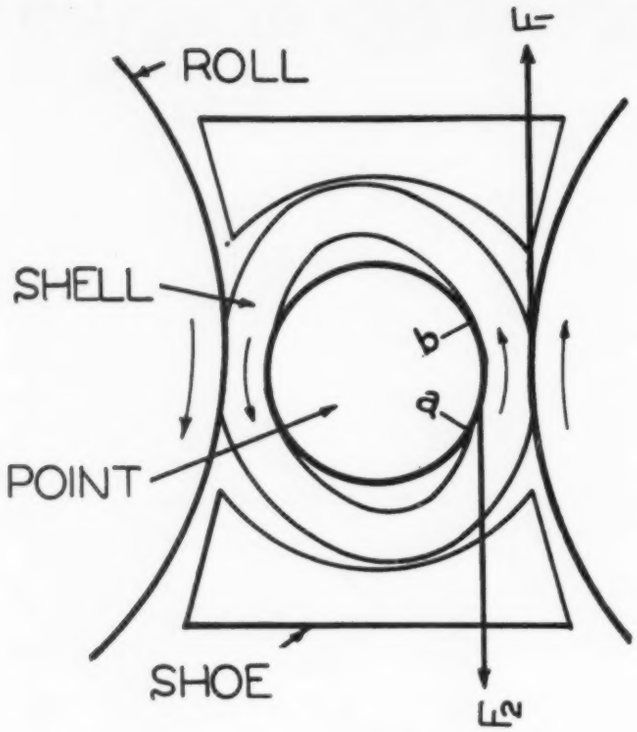


Figure 6 — Vertical section of piercing mill illustrates origin of circumferential shear.

There are three redundant deformations which have been observed to occur in the piercing of wax billets. These will be referred to as the twist, the longitudinal shear, and the circumferential shear.

The twist, as the name implies, is simply a torsional deformation. In the billets containing the colored wax filaments, the filaments are originally straight and parallel to the billet axis. The twisting action which occurs in piercing converts a straight filament to a helix. It is well known that twist occurs in piercing steel billets from the spiral nature of outside seams when they are found.

The deformation called longitudinal shear can be visualized as follows: Imagine the pierced billet to be composed of a number of thin wall tubes telescoped together. Longitudinal shear exists when the outer tubes are moved longitudinally relative to the inner tubes.

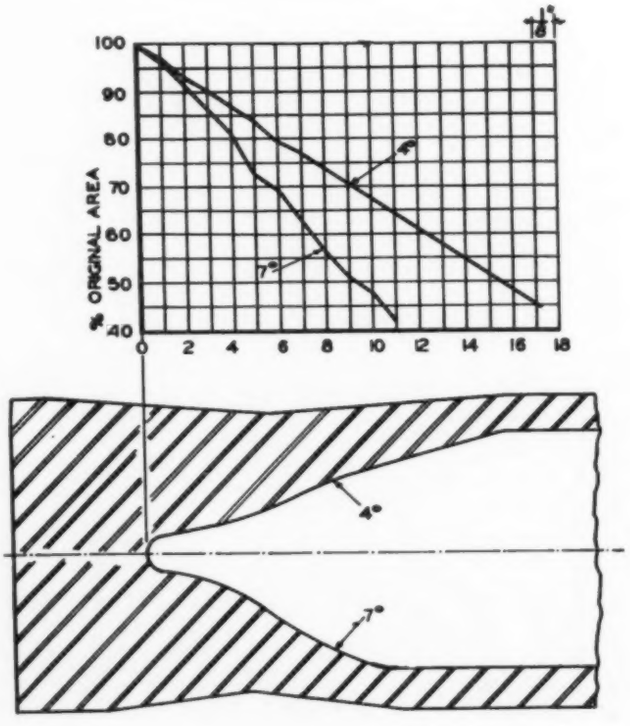
Circumferential shear can be visualized in the same manner. Circumferential shear exists when the outer tubes are rotated relative to the inner ones. This deformation could be called tangential shear, the writer has used the term circumferential shear in preference.

The origin of twist in the pierced billet is rather obvious. It is due to the fact the rolls are largest in the center and taper toward both ends. The billet also varies in diameter along the contact with the roll surface and the ratio of billet diameter to roll diameter is not constant. In consequence, there is not pure rolling contact. The difference in peripheral speed of roll and billet must be accommodated by twisting of the billet, or by slippage of the roll on the billet surface, or both. The extent to which each occurs depends on several factors. Some of these are the coefficient of friction between roll and billet, amount of draft, roll angle, wall thickness of the shell, shear strength of the material, and the shape of the point.

The origin of longitudinal shear is also obvious. The rolls exert a forward longitudinal component of force on the outer surface of the billet, and the piercer point exerts a backward longitudinal force on the center material of the billet. These two parallel but oppositely directed forces shear the shell wall longitudinally.

The origin of circumferential shear is not as directly perceivable as the origin of twist and longitudinal shear. A tentative explanation is advanced, however, with the aid of Figure 6. Figure 6 shows diagrammatically a vertical section through the shell and piercer point (perpendicular to the pass line). Due to ovalizing, the shell and piercer point have a limited arc of contact a-b. Under the roll pressure, the sides of the piercer point indent the inner wall of the shell, producing a hump as indicated at "a". Since the inside periphery of the shell is greater than the perimeter of the piercer point, there is rolling contact between the sides of the piercer point and the inner surface of the shell. The hump at "a" offers resistance to the passage of the shell wall through the narrowing space between the piercer point and outer roll. This resistance is overcome by the tractive force which the piercer roll exerts on the outer surface of the shell. In Figure 6, the tractive force exerted on the outer surface of the shell is indicated by the vector F_1 and the resistance offered by the hump is indicated by the vector F_2. This pair of parallel but oppositely directed forces shear the shell wall tangentially and produce the deformation called circumferential shear. With the directions of rotation as shown in Figure 6, the forces F_1 and F_2 produce shearing strain in a direction such that the outer surface of the shell is rotated in a counterclockwise direction relative to the inner surface

Figure 7 — Shape of point cavity and curves show corresponding uniform reduction rate schedules.



of the shell. With the directions of rotation as shown in Figure 6 (viewed from the outlet side of the piercing mill), it has been observed in both wax and steel billets that the outer surface of the shell is rotated counterclockwise relative to the inner surface of the shell. This observation is in conformity with the foregoing explanation.

A question which naturally arises with regard to the experimental procedure is whether the deformations which occur in a wax billet in piercing on the model mill fairly represent the deformation which occur in steel billets when pierced on production equipment. Certainly there can be no difference with respect to the basic deformations, they must be the same. It can hardly be doubted that the same kind of redundant deformations occur although they may differ in degree in wax and steel. An experiment has been made to compare the redundant deformations which occur in wax with those which occur in steel. The results obtained in this experiment will be presented in connection with the discussion of the results obtained in piercing wax billets with different rates of reduction of section area in the piercing operation.

EFFECT OF RATE OF REDUCTION OF SECTION AREA ON DEFORMATIONS

An investigation has been made of the effect of the rate of reduction of cross section area on the deformations occurring in the piercing operation. It was decided to investigate three types of reduction schedules:

1. Uniform rate. For each equal increment of advance along the point cavity, an equal increment of percentage reduction of the original cross section area is taken.
2. Decelerated rate. The increments of percentage reduction in original cross section area, corresponding to equal increments of advance along the point cavity, are largest at the bottom of the cavity and continuously decrease as the other end of the cavity is approached.
3. Accelerated rate. The increments of percentage reduction in original cross section area, corresponding to equal increments of advance along the point cavity, are smallest at the bottom of the cavity and continuously increase as the other end of the cavity is approached.

For each type of reduction schedule, two rates of reduction were used, corresponding to rolls cut with a 7 degree and a 4 degree angle.

The shape of the point cavities and the curves of cross section area versus position along the point cavity are shown in Figures 7, 8, and 9. The rate of reduction at any position along the cavity is the slope of the curve of area versus position at that position. Piercer points were made conforming to the shape of the cavities. Billets of the A and B type were pierced with these points. The piercing operation was stopped when the point had penetrated to the desired depth in the billet. After piercing, billets of the A type were cut transversely at various positions along the point cavity to show the position, size, and shape of the filaments. These sections were photographed. Billets of the B type were cut longitudinally to show the deformation of the wafers. These sections were also photographed.

Billets of the A type yielded information concerning

Figure 8 — Shape of point cavity and curves show corresponding decelerated reduction rate schedules.

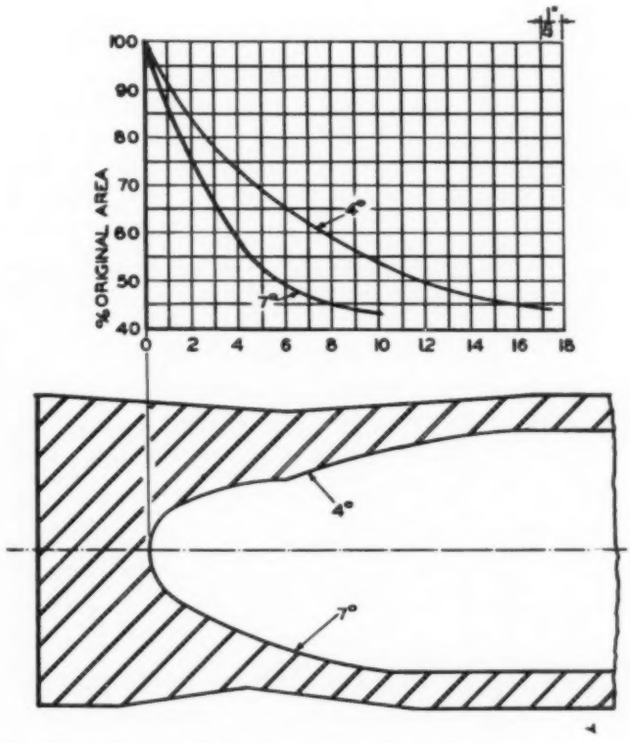
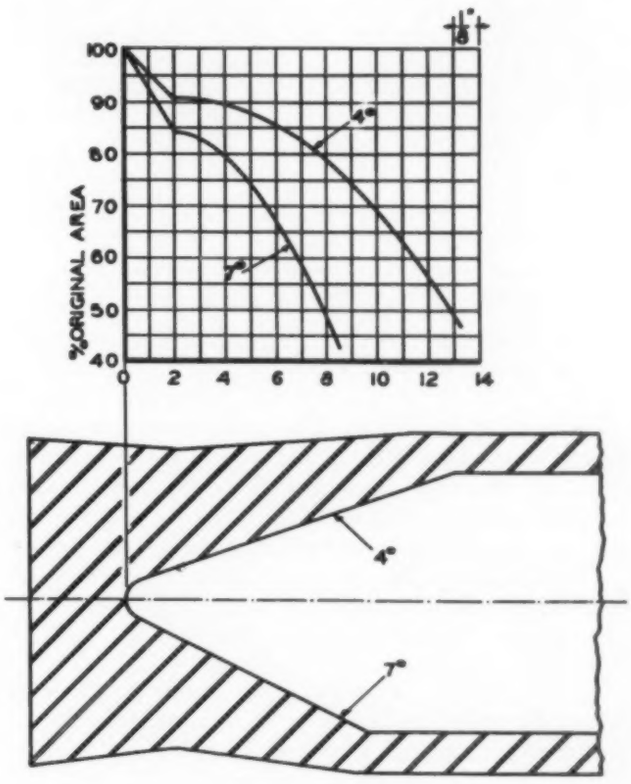


Figure 9 — Shape of point cavity and curves show corresponding accelerated reduction rate schedules.



the rate of reduction of cross-sectional area, and angular displacements of the filaments due to the redundant deformations. Billets of the B type yielded information on the longitudinal shear.

RATE OF REDUCTION OF SECTION AREA

A group of transverse sections cut from a specimen pierced from an A type billet is shown in Figure 10. Twelve sections were cut from each specimen. The transverse sections were used to check the actual rate of reduction against the intended rate. Due to ovalizing, the point cavity does not conform exactly to the shape of the piercer point and therefore the actual rate of reduction might differ somewhat from the intended rate. The draft and the point setting will also affect the rate of reduction. The check on rate of reduction was made in two ways: (1) The annular section area was measured in each transverse section, and (2) the area of each filament was measured in each transverse section.

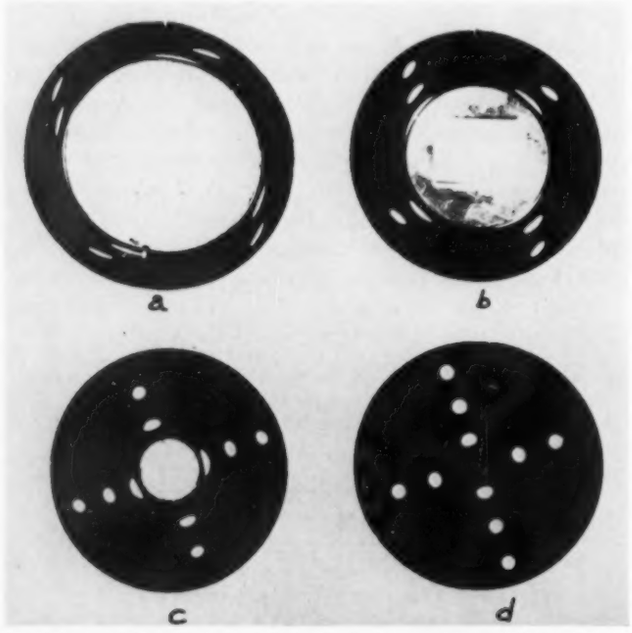


Figure 10 — Transverse sections through A Type billet pierced with uniform rate point, 4 degree rolls.

a. Section at $1\frac{13}{16}$ in. from cavity bottom.
b. Section at $1\frac{7}{32}$ in. from cavity bottom.
c. Section at $\frac{1}{2}$ in. from cavity bottom.
d. Section at cavity bottom.

The transverse sections were photographed on small lantern slide plates. These plates were projected on a screen at about 25 diameters magnification for area measurements on the filaments. The area of each filament was measured by means of a planimeter working on the enlarged image and the true area obtained by calculation from the magnification ratio. Areas of the full section were planimetered on slightly enlarged photographic prints made from the plates.

Curves showing the actual reduction schedule were obtained by plotting the areas of the filaments and of the full section against position along the point cavity. These curves are shown in Figures 11 to 16 inclusive.

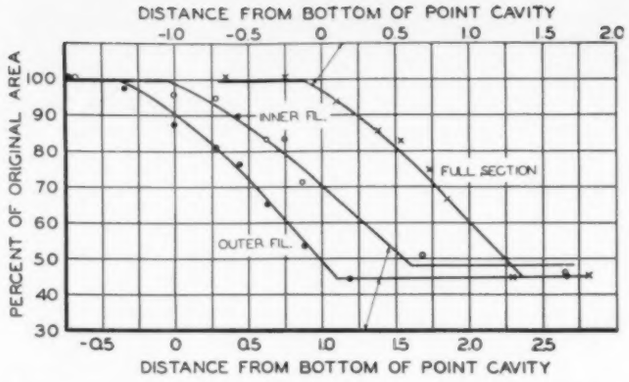

DISTANCE FROM BOTTOM OF POINT CAVITY
-1.0 -0.5 0 0.5 1.0 1.5 2.0
PERCENT OF ORIGINAL AREA
100 90 80 70 60 50 40 30
INNER FIL.
FULL SECTION
OUTER FIL.
-0.5 0 0.5 1.0 1.5 2.0 2.5
DISTANCE FROM BOTTOM OF POINT CAVITY

Figure 11 — Rate of reduction curves for Type A billet pierced with uniform rate point and 7 degree roll angle.

To avoid excessive complication of the figures, curves for the innermost and outermost filaments only, are shown. The curves for the intermediate filaments fall in general between these two curves when plotted.

By comparing Figures 11 to 16 with Figures 7, 8 and 9, it will be observed that in the case of the uniform and

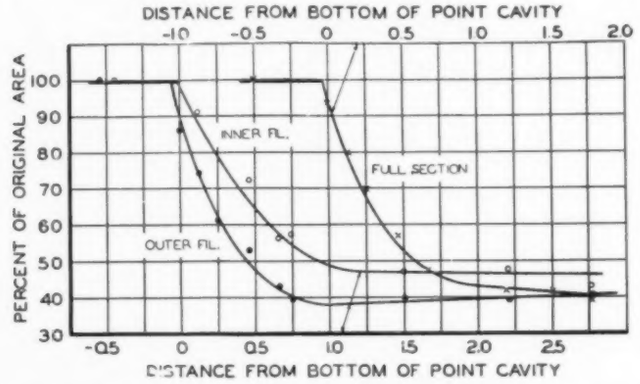
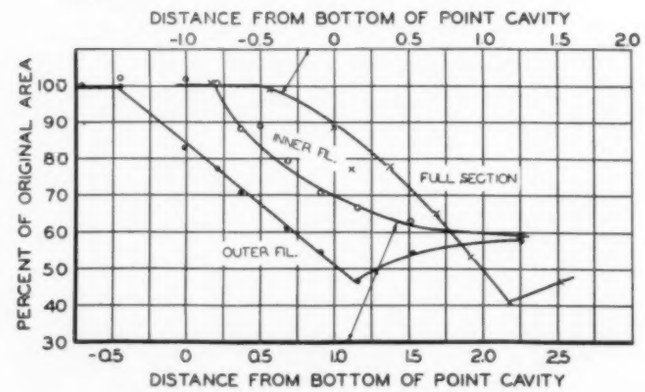

DISTANCE FROM BOTTOM OF POINT CAVITY
-1.0 -0.5 0 0.5 1.0 1.5 2.0
PERCENT OF ORIGINAL AREA
100 90 80 70 60 50 40 30
INNER FIL.
FULL SECTION
OUTER FIL.
-0.5 0 0.5 1.0 1.5 2.0 2.5
DISTANCE FROM BOTTOM OF POINT CAVITY

Figure 12 — Rate of reduction curves for Type A billet pierced with decelerated rate point and 7 degree roll angle.

decelerated reduction rate piercer points, the actual reduction schedules approximate reasonably well the intended reduction schedule. In the case of the billets pierced with the accelerated rate piercer point, particularly as shown in Figure 13, the reduction rate obtained

Figure 13 — Rate of reduction curves for Type A billet pierced with accelerated rate point and 7 degree roll angle.


DISTANCE FROM BOTTOM OF POINT CAVITY
-1.0 -0.5 0 0.5 1.0 1.5 2.0
PERCENT OF ORIGINAL AREA
100 90 80 70 60 50 40 30
INNER FIL.
FULL SECTION
OUTER FIL.
-0.5 0 0.5 1.0 1.5 2.0 2.5
DISTANCE FROM BOTTOM OF POINT CAVITY

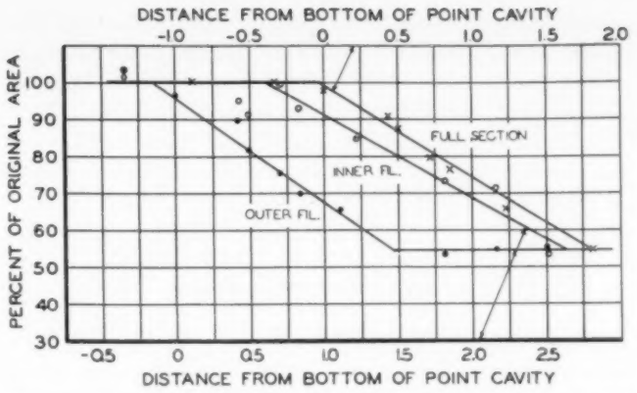

DISTANCE FROM BOTTOM OF POINT CAVITY
-10 -0.5 0 0.5 1.0 1.5 2.0
PERCENT OF ORIGINAL AREA
100 90 80 70 60 50 40 30
FULL SECTION
INNER FIL.
OUTER FIL.
-0.5 0 0.5 1.0 1.5 2.0 2.5
DISTANCE FROM BOTTOM OF POINT CAVITY

Figure 14 — Rate of reduction curves for Type A billet pierced with uniform rate point and 4 degree roll angle.

from the filament measurements differs materially from the rate obtained on the full section measurements. This curve and the curve for the companion point, Figure 16, both show a peculiarity in that the filaments increase in area again toward the large end of the piercer point cavity. The writer views this result with some

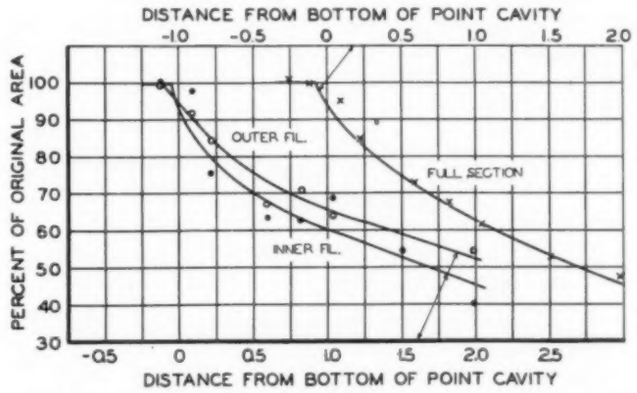
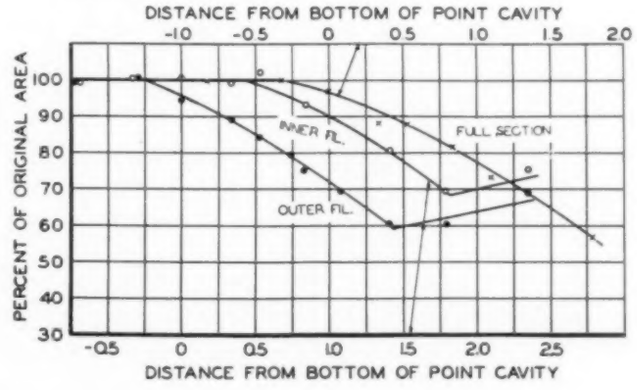

DISTANCE FROM BOTTOM OF POINT CAVITY
-10 -0.5 0 0.5 1.0 1.5 2.0
PERCENT OF ORIGINAL AREA
100 90 80 70 60 50 40 30
OUTER FIL.
FULL SECTION
INNER FIL.
-0.5 0 0.5 1.0 1.5 2.0 2.5
DISTANCE FROM BOTTOM OF POINT CAVITY

Figure 15 — Rate of reduction curves for Type A billet pierced with decelerated rate point and 4 degree roll angle.

doubt as to its validity. It is known from other evidence that occasionally there is a local enlargement of a filament due to the occurrence of a small shrinkage cavity around a rod used to form a channel in the cast billet. It would be a coincidence that this occurred in about

Figure 16 — Rate of reduction curves for Type A billet pierced with accelerated rate point and 4 degree roll angle.


DISTANCE FROM BOTTOM OF POINT CAVITY
-10 -0.5 0 0.5 1.0 1.5 2.0
PERCENT OF ORIGINAL AREA
100 90 80 70 60 50 40 30
INNER FIL.
FULL SECTION
OUTER FIL.
-0.5 0 0.5 1.0 1.5 2.0 2.5
DISTANCE FROM BOTTOM OF POINT CAVITY

the same place on both billets used with the accelerated rate point, thus the fact that it occurred on both billets tends to support the validity of the data. However, additional tests should be made to determine whether this result is consistently obtained with the accelerated rate type of point.

The curves show that in general the outer filament undergoes reduction of area before the inner filament does, i.e., at sections near the bottom of the piercer point cavity the rate of longitudinal extension of the material is greater at the outside of the billet than at the center.

TWIST

The twist was measured on the straight portion of the shell between the entering end and the point cavity. Twist measurements were made on the inner and outer filaments. The pitch of the filament helix, expressed as a multiple of the outside diameter of the shell, is given in Table I. This table also gives the proportions of the shell expressed as the ratio of outside diameter to wall thickness.

It will be noted that with both the 7 and 4 degree roll angles, the decelerated rate point resulted in the least severe twisting action. The most severe twisting action occurred with the accelerated rate point and 4 degree roll angle. It will further be noted that in all specimens the twist is closely the same at the inside and outside surfaces of the shell.

TABLE I

Reduction schedule	Roll Angle, degrees	D/t ratio	Twist	
			Outer filament	Inner filament
Uniform rate	7	8.8	P=4.05D	P=4.27D
Decelerated rate	7	8.3	P=7.63D	P=7.88D
Accelerated rate	7	7.9	P=4.38D	P=4.88D
Uniform rate	4	7.0	P=4.45D	P=4.24D
Decelerated rate	4	7.4	P=5.82D	P=5.80D
Accelerated rate	4	6.8	P=2.34D	P=2.41D

P = pitch of twist helix.
D = outside diameter of shell.
t = wall thickness of shell.

ANGULAR DISPLACEMENT OF FILAMENTS

The transverse sections were also used to measure the angular displacement of the filaments. In the type A billets the filaments are spaced along radial lines. Considering one of the groups of three filaments all lying on the same radial line in the billet before piercing, after piercing these three filaments do not lie on the same radial line. Compare sections "a" and "d," Figure 10. If radial lines are drawn through the center of each filament after piercing, the angle between the radial line passing through the innermost and middle filament measures the angular displacement of the middle filament relative to the innermost filament. Similarly the angle between radial lines passing through the middle and outermost filaments measures the angular displacement of the outermost filament relative to the middle filament. The sum of these two angles measures the

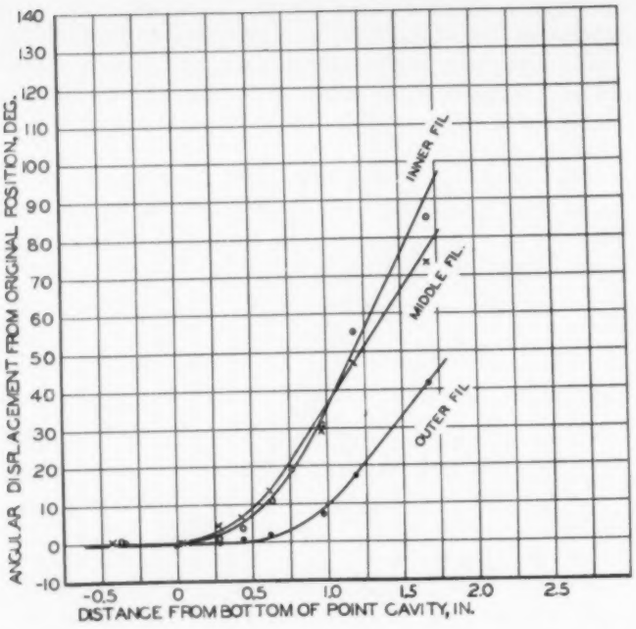


Figure 17 — Angular displacement of filaments for uniform rate point and 7 degree roll angle.

angular displacement of the outermost filament relative to the innermost filament.

The angular displacement of the filaments arises from two sources. These are: (1) circumferential shear, and (2) the combination of twist and longitudinal shear. The angular displacement seen in the transverse sections is the total result arising from both sources. The resolution of the total angular displacement into the separate components will be discussed further on.

A longitudinal line was scribed on the outside of the pierced billet before transverse sections were cut. In each section the angular position of each filament relative to the scribed line was measured. The measurements were made with a protractor on photographic prints of the transverse sections. The angular positions of the filaments were plotted against position along the point cavity to give the curves shown in Figures 17 to 22 inclusive. In these figures, only the curves for the innermost, middle, and outermost filaments are shown, to simplify the figures.

LONGITUDINAL SHEAR

Longitudinal sections through shells pierced from type B billets were used to reveal the longitudinal shearing strain. These sections are shown in Figure 23.

The longitudinal displacement of the filament helices was obtained from these photographs as follows: On the wafer most remote from the bottom of the point cavity a tangent line was drawn representing the average slope of the interface between the differently colored wafers. The tangent line averaged the slope over the radial distance between the innermost and outermost filaments. The longitudinal displacement of the filament helices was calculated from the slope of the tangent line and the radial distance between the filaments. The radial distances between the filaments were obtained from the photographs of the transverse sections.

RESOLUTION OF ANGULAR DISPLACEMENT INTO COMPONENT PARTS

The angular displacement due to the combination of twist and longitudinal shear is illustrated by Figure 24 which represents a shell element containing a filament on the inner and outer surfaces. If only torsional deformation occurred, the ends of the filament which lie along the radial line A-B on one end of the section would lie along the radial line C-D on the opposite end.

Figure 18 — Angular displacement of filaments for decelerated rate point and 7 degree roll angle.

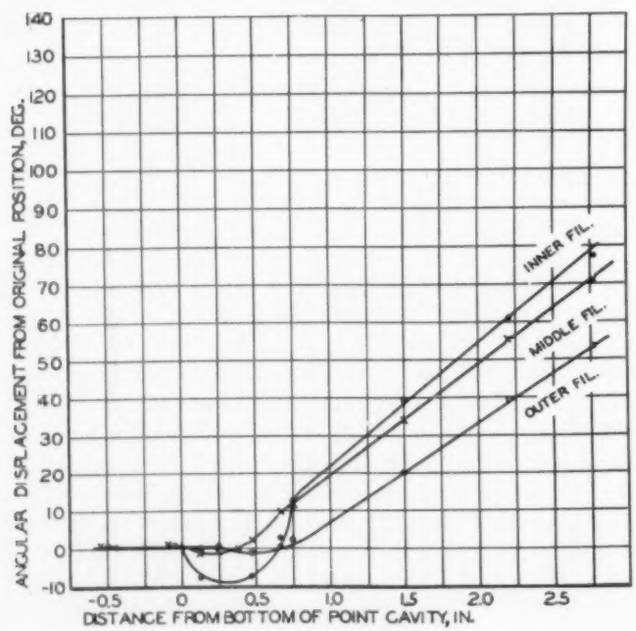
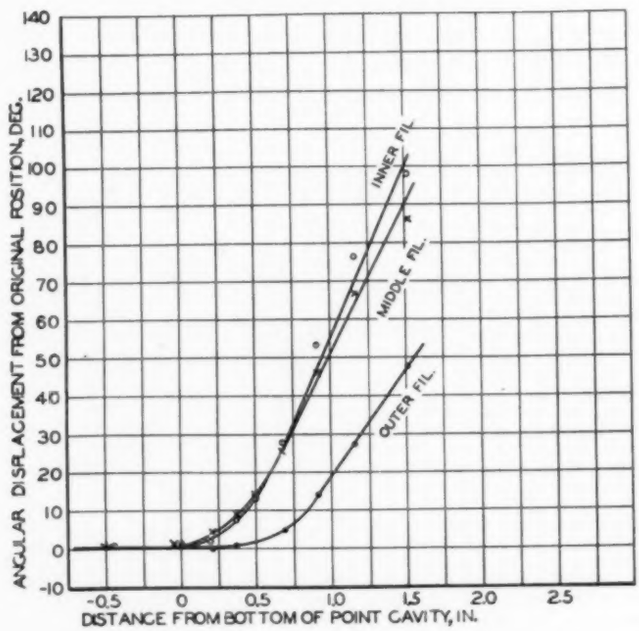


Figure 19 — Angular displacement of filaments for accelerated rate point and 7 degree roll angle.



However, when the outer surface is displaced a distance x longitudinally relative to the inner surface, a point F on the outer filament is brought into the end section to occupy the position denoted by G. The radial line C-E through G makes the angle θ with the radial line C-D. The angle θ is the angular displacement due to the combination of twist and longitudinal shear. This angle is equal to the product of the twist in degrees per inch and the longitudinal displacement x in inches. Table II gives the values of θ and pertinent data from which they were calculated.

The angular displacement of the filaments shown in the transverse sections is the sum of the angular displacement due to combined twist and longitudinal shear, and the angular displacement due to circumferential shear only.

The total angular displacement of the filaments was taken from the curves shown in Figures 17 to 22 inclusive. The angular displacement, corresponding to the spread between the curves, was taken at the section most remote from the plug cavity bottom. The total angular displacement is tabulated in Table III along with the angular displacement due to circumferential shear only.

Table III shows a substantial degree of circumferential shear occurring in specimens I and III, while it is low in all the others. The last column in Table III would indicate, in the case of specimens IV and VI, that circumferential shear action occurred only on the material near the inner surface of the shell. In view of the origin of this deformation, such a result appears unlikely. It is probably due to inaccuracy in the data that this result was obtained.

TEST ON STEEL BILLETS

For the purpose of comparing the redundant deformations occurring in wax billets pierced on the model mill with those occurring in piercing steel billets on production equipment, several steel billets were prepared as shown in Figure 25. A billet was slotted out at midlength down to the center plane and the slot filled in with weld metal deposited by arc welding.

The deposited weld metal corresponds to one-half of a wax wafer as used in the type B billet. Low carbon weld rod was used on a medium carbon billet so that the weld metal could be distinguished from the billet metal by acid etching after piercing.

The billet was 6.60 in. in diam and was pierced to a shell 7 in. outside diameter by slightly under one-inch wall thickness. The shell had a D/t ratio of 7.4 corre-

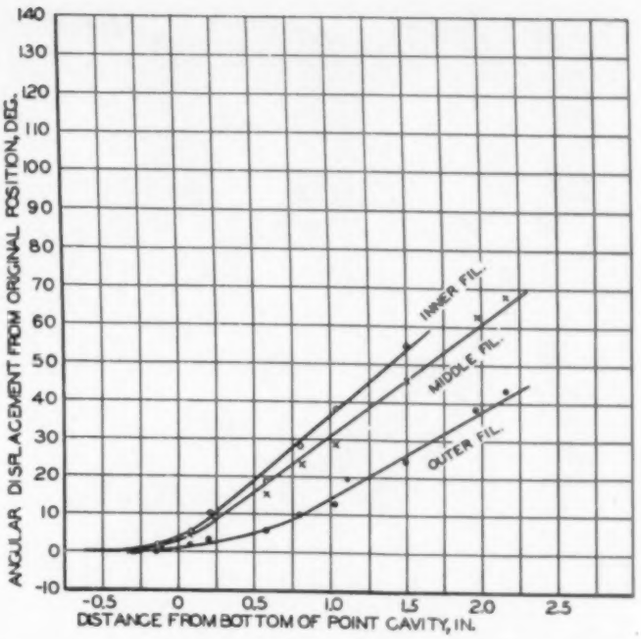


Figure 21 — Angular displacement of filaments for decelerated rate point and 4 degree roll angle.

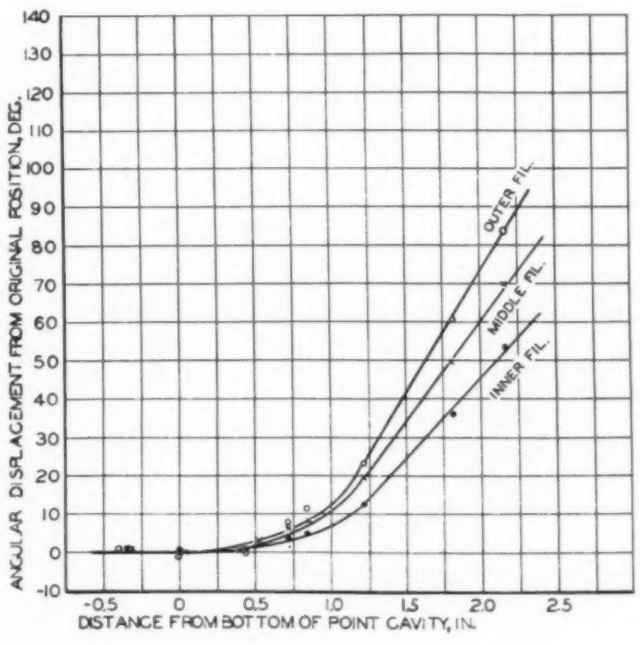


Figure 20 — Angular displacement of filaments for uniform rate point and 4 degree roll angle.

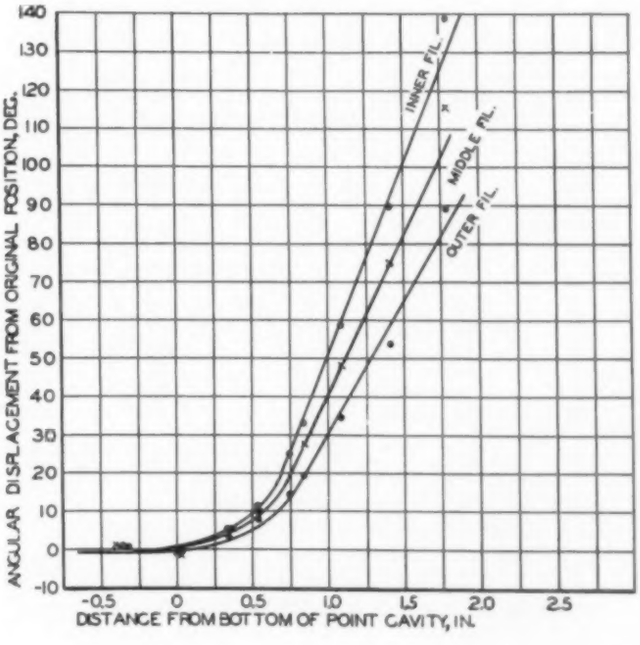


Figure 22 — Angular displacement of filaments for accelerated rate point and 4 degree roll angle.

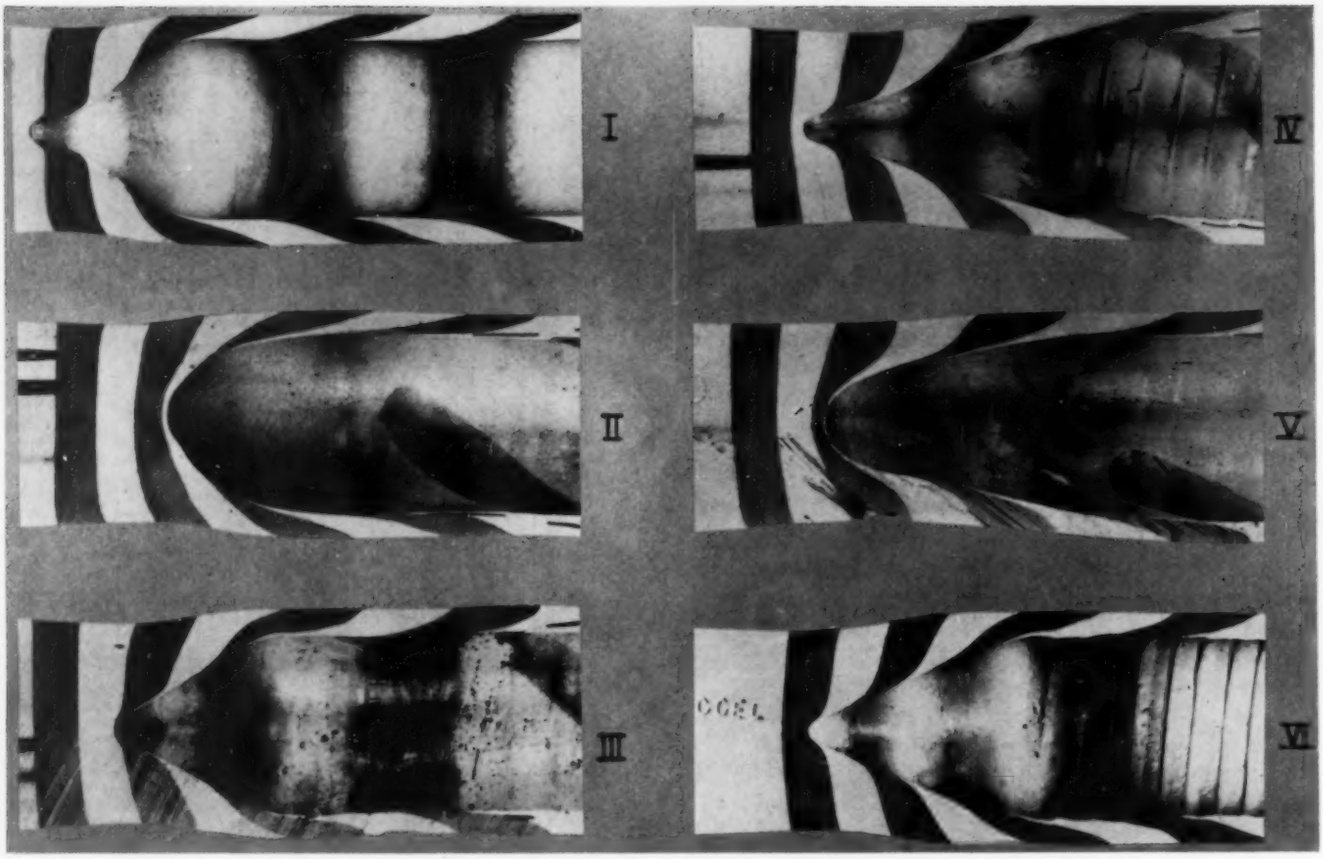


Figure 23 — Longitudinal sections through Type B billets.

I. 7 degree roll, uniform rate.
II. 7 degree roll, decelerated rate.
III. 7 degree roll, accelerated rate.
IV. 4 degree roll, uniform rate.
V. 4 degree roll, decelerated rate.
VI. 4 degree roll, accelerated rate.

sponding approximately to the D/t ratio of the wax shells.

The interface between the weld metal and billet metal along the diameter B-C, Figure 25, serves to reveal the angular displacement due to circumferential shear and the combined effect of twist and longitudinal shear. The interface between the weld metal and billet metal, D-E, Figure 25, serves to reveal the longitudinal shear deformation.

After piercing, the resulting shell was acid pickled to locate the section containing the weld metal. The twist was readily measured from surface markings revealed by the pickling. In terms of the outside diameter of the shell the pitch spiral was found to be: $P = 455D$ where

TABLE II

Angular Displacement of Filaments Due to Combined Twist and Longitudinal Shear

Specimen	Reduction schedule	Roll angle, degrees	Longitudinal shear angle, degrees, measured from longitudinal axis	h_1, in.	h_2, in.	D_1, in.	D_2, in.	Twist, degrees per in.	θ_1 degrees	θ_2 degrees
I	Uniform	7	20	0.028	0.091	0.077	0.250	50.4	4	13
II	Decelerated	7	12	0.030	0.104	0.141	0.488	27.2	4	13
III	Accelerated	7	20	0.036	0.095	0.099	0.261	43.7	4	11
IV	Uniform	4	16	0.049	0.142	0.171	0.495	47.2	8	23
V	Decelerated	4	12	0.040	0.121	0.188	0.568	35.8	7	20
VI	Accelerated	4	17	0.051	0.145	0.167	0.474	86.2	14	41

h_1 = radial distance, inner to middle filament.
h_2 = radial distance, inner to outer filament.
D_1 = longitudinal displacement, inner to middle filament.
D_2 = longitudinal displacement, inner to outer filament.
θ_1 = angular displacement, middle to inner filament.
θ_2 = angular displacement, outer to inner filament.

TABLE III

Total Angular Displacement and Angular Displacement Due to Circumferential Shear Only

Specimen	ϕ_1 degrees	ϕ_2 degrees	θ_1 degrees	θ_2 degrees	w_1 degrees	w_2 degrees	w_1-w_2 degrees
I	11	42	4	13	7	29	22
II	9	26	4	13	5	13	8
III	22	52	4	11	18	41	23
IV	14	29	8	23	6	6	0
V	16	36	7	20	9	16	7
VI	24	51	14	41	10	10	0

ϕ_1 = total angular displacement, middle to inner filament.
ϕ_2 = total angular displacement, outer to inner filament.
w_1 = circumferential shear angle, middle to inner filament.
w_2 = circumferential shear angle, outer to inner filament.

P is the pitch and D the outside diameter. This corresponds rather closely to the twist found on the wax specimens I, III, and IV. The roll angle was 4-½ degrees inlet end and 3-½ degrees outlet end.

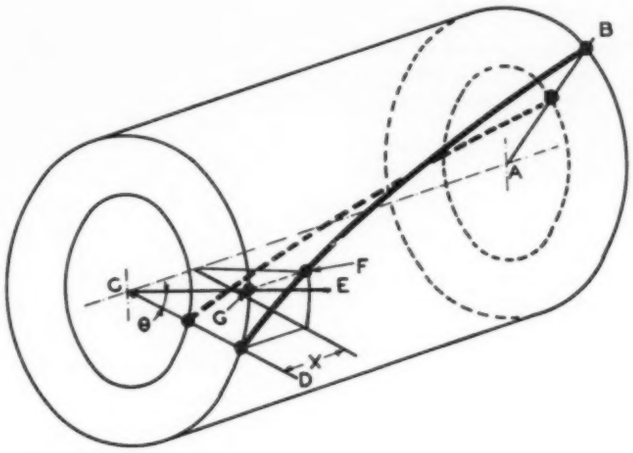


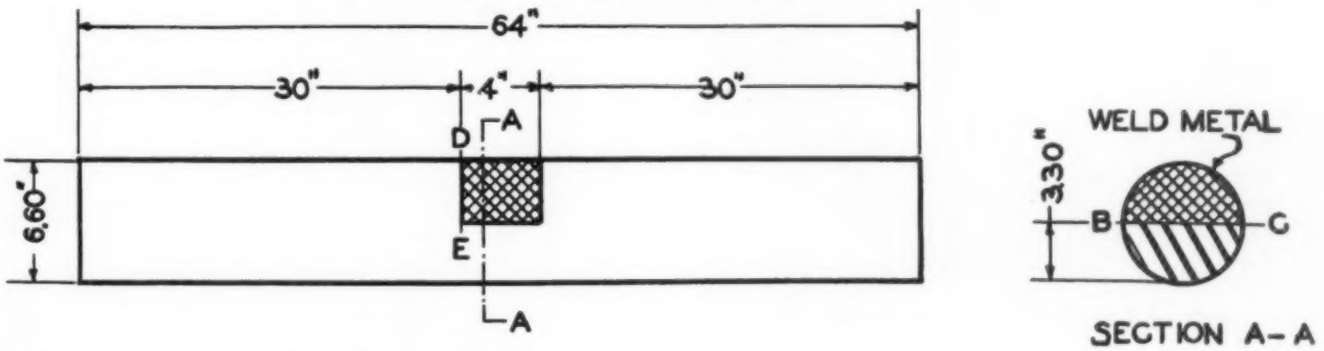
Figure 24 — Angular displacement due to combination of twist and longitudinal shear.

A ring was cut from the shell in the weld metal section and is shown in Figure 26 after etching. A longitudinal strip is shown in the same figure. The longitudinal strip shows a much smaller longitudinal shear deformation that was found in the wax models. The ring shows a decided spiral configuration of the initially radial interface between weld and billet metal. Since the longitudinal shear is small, this is substantially all due to circumferential shear. In Figure 27, the spiral as traced from the etched ring is shown. The fit of the spiral to computed points for a logarithmic spiral curve is indicated by the plotted points shown in the figure. It will be noted that the spiral interface revealed by etching approximates closely a true logarithmic spiral. It is a property of the logarithmic spiral that the angle γ between tangent and radius through any point is constant. Consequently, the circumferential shear strain which is measured by γ is constant across the wall thickness. For the spiral shown, $\gamma = 77$ degrees.

CONCLUSION

It is concluded that the model wax billet method can be satisfactorily used for the investigation of the piercing operation on a laboratory scale. The basic deformations which occur in piercing are the same regardless of material and are of the same magnitude in geometrically equivalent positions in geometrically similar models regardless of actual size. Redundant deformations of the same kind occur in piercing wax and steel, but they may differ in magnitude as a consequence of the difference in properties of the two materials. Although insufficient tests have made to fully establish a relationship, it appears that wax may exhibit longitudinal shear to a greater degree than steel in piercing. A number of possibilities exist whereby closer corre-

Figure 25 — Steel billet used to reveal redundant deformations.



spondence might be obtained with respect to longitudinal shear. These are: a different piercing temperature, a different piercing speed, or a different wax composition than were used in this investigation.

For useful results to be obtained, however, it is not essential that the redundant deformations be identical in magnitude in wax and steel. If a certain change in piercing conditions tends to alter a redundant deformation in wax, the same change in piercing conditions would tend to alter it in the same direction in steel. By means of model wax billets and model piercing equipment, investigations can be carried out in scope and detail which would be prohibitively expensive to carry out with production material and equipment.

It is only with respect to the redundant deformations that there can be any hope for achieving control. The basic deformations are inherent to the conversion of the solid billet to the hollow shell and cannot be altered or avoided.

The investigation of the rate of reduction on the redundant deformations did not reveal a simple pattern of relationship. The decelerated rate point gave the least twist with both 4 and 7 degree roll angles. The billets pierced with the points for 4 degree roll angle showed as a group less circumferential shear than those pierced with the points for 7 degree roll angle. It is uncertain, however, whether the lesser tendency toward circumferential shear can be attributed to the difference in points, since these specimens as a group had greater wall thickness than the group pierced with the points for 7 degree roll angle. Further tests and analyses should be made before any final conclusions are drawn regarding the effect of reduction rate on the redundant deformations.

Figure 26 — Longitudinal and transverse sections through weld metal regions of billet, shown in Figure 25, after piercing.

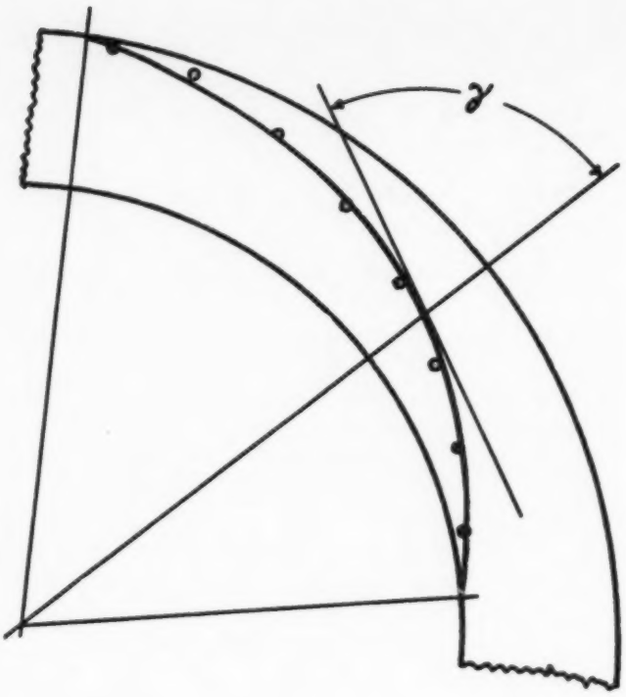


Figure 27 — Fit of spiral interface between weld and billet metal to logarithmic spiral. Spiral interface traced from an etched ring as shown in Figure 26.

APPENDIX

Change in position and shape of filaments by the basic deformations—The procedure for transposing a filament from its original position and shape in the billet to the final position and shape in the pierced shell is illustrated with the assistance of Figure 28.

Consider a surface of radius r inside a billet of radius a, which is expanded to a radius R by piercing. The volume of material, V_1, enclosed by the surface of radius r in the billet is:

$$V_1 = \pi r^2 l \qquad (I)$$

where l is the length of the billet.

After piercing, the volume of material, V_2, in the pierced shell enclosed between the radius R and the inner surface of radius b is:

$$V_2 = \pi(R^2 - b^2)L \qquad (II)$$

where L is the length of the pierced shell.

Since V_1 and V_2 are equal, equations (I) and (II) give the result:

$$R^2 = \frac{l}{L} r^2 + b^2 \qquad (III)$$

The volume of material in the pierced shell is the same as the volume of material in the billet, so that:

$$\pi a^2 l = \pi(c^2 - b^2)L$$

or:

$$\frac{l}{L} = \frac{c^2 - b^2}{a^2} \qquad (IV)$$

where c is the outside radius of the pierced shell. Substituting in (III) there results:

$$R = \sqrt{\frac{(c^2 - b^2)}{a^2} r^2 + b^2} \qquad (V)$$

Equation (V) is the required relation between r and R.

The transposing procedure may now be carried out as shown in Figure 28a. A radius r is drawn through the filament intersecting it at points 1 and 2. the radius R is calculated from equation (V) and drawn. Lines from the center O are drawn through 1 and 2 to intersect the arc of radius R at 3 and 4. Points 3 and 4 lie on the periphery of the transposed filament. The procedure is repeated until enough points have been transposed so that a smooth curve can be drawn through them to outline the shape of the filament after piercing. The transposed position of the filament is, of course, simultaneously determined.

Figure 28b shows the result obtained by the above procedure carried out for a group of three filaments lying on the same radius in the A type billet. The original work was done on a scale twenty times actual size and photographically reduced to the size shown. The solid black areas show the filaments after piercing, the open circles the filaments before piercing and the dashed line ovals indicated the angular displacement of the filaments after piercing in consequence of the redundant deformations. Figure 28b may be compared with Figure 10a to note the correspondence between theory and experiment.

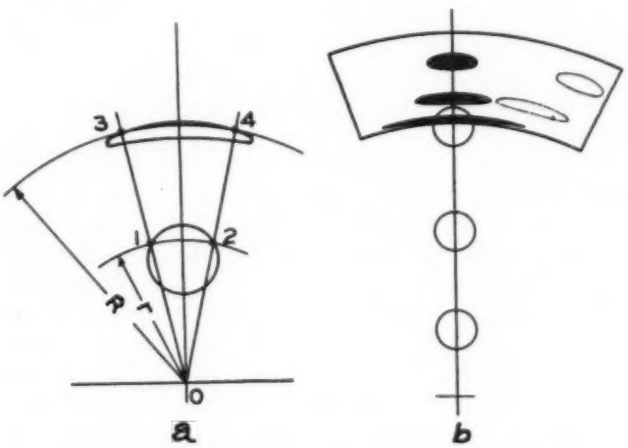


Figure 28 — Effect of basic deformations.

- **a. Method of transposing shape and position of filament in billet to shape and position in pierced shell.**
- **b. Result obtained by applying method of Figure 28a to row of filaments in Type A billet.**

In addition to the basic and redundant deformations which have been described, additional deformations occur at the extreme ends of the billet. At the entry end, for example, a deformation occurs which is in the nature of a bending over of the outer surface toward the axis. The filaments show this very clearly. The end of the innermost filament, for example, is found on the inner surface of the shell about ½ in. from the end of the shell. Consequently, the assumption of equal longitudinal stretching across the wall thickness is not quite correct. In billets which are long compared to their diameter, the volume of material involved in the bending deformations at the ends is only a small part of the total material in the billet, so the assumption of uniform longitudinal elongation is a close approximation.

DISCUSSION

PRESENTED BY

PAUL E. FLAUTZ, Assistant Hot Mill Superintendent, Pittsburgh Steel Co., Allenport, Pa.

H. R. McLAREN, Assistant General Superintendent, Steel and Tube Division, Timken Roller Bearing Co., Canton, Ohio

A. B. CAPRON, Chief Engineer, Babcock & Wilcox Co., Tubular Products Division, Beaver Falls, Pa.

J. L. HOLMQUIST, Director of Research, Spang-Chalfant Division, National Supply Co., Ambridge, Pa.

M. D. STONE, Manager, Development Department, United Engineering and Foundry Co., Pittsburgh, Pa.

M. S. GETTIG, Superintendent Seamless Tube Mills, The Youngstown Sheet & Tube Co., Youngstown, Ohio

Paul E. Flautz: The manner of material displacement within the Mannesmann piercing process has been ably described by Mr. Holmquist. The conclusion that wax billets can be satisfactorily used for the investigation of piercing on a laboratory scale seems well founded.

A great deal of research and detailed study have certainly been required for this treatise. It is unfortunate that the tabulated data did not reveal a more specific pattern of relationship between the redundant forces. With the limited trials, however, a simple relationship or pattern of accuracy could hardly be hoped for.

The complexity of forces acting within cross roll piercing processes almost defy simple explanation. Compression, tension, and shear exist to various degrees of intensity and direction. These forces present a confusing but intriguing study. Mr. Holmquist's method of analyzing them via redundant deformations is interesting and logical. There could be hidden factors uncovered which would ultimately lead to multiple improvements in piercer pass design.

Modern piercing mill passes in use were designed fundamentally to obtain the maximum number of work increments in processing with progressive uniform area reduction per increment. In effect, most of these passes create slightly decelerated rates of material deformation throughout their length. All angular displacement resulting therefrom is accepted as essential to the process. Little attention has been given in general to either the total magnitude of angular deformation or rates of redundant deformations, i.e., as prime factors in the pass design.

We know from daily operational evidence that angular displacement from torsional twist regularly exceeds 30 degrees per in. of pierced shell for some piercing mills. Others produce similar shell sizes with a considerably less amount of twist. In some instances, the degree of displacement from this source is practically

nil. Within limits this twist intensity can be varied for any specific piercing pass by mere alteration of mill set up. Increasing the amount of material displacement in the converging section of the pass will lessen twist angle in a Mannesmann piercer.

There is no readily visible evidence in operations of the angular displacement amount due to circumferential shear or longitudinal shear. As shown after research these displacements in total are of considerable magnitude. They can probably be made to vary over a fairly wide range by alteration of mill set up. The data indicates wide variance for different types of piercing passes. More research is needed for proof.

Throughout the industry, rates of transformation from solid to tubular shell are being made over a wide range of speeds. Maximum peripheral roll speeds of 1200 to 1500 fpm with ten degree piercer roll obliquity are being successfully employed. This means that the redundant deformations as herein discussed are being made at a correspondingly rapid rate.

During piercing, steel in plastic flow will withstand total angular displacement of considerable magnitude with quite rapid deformation rates without harmful effects to the steel, i.e., if it is good sound piercing quality steel.

Seamless tube piercing mills in general probably demand a higher quality steel and steel surface combined, than any other hot rolling process in the industry. The type of rolling forces being discussed here are the reason for this rigidity of specification. Any research which uncovers a better method of controlling and minimizing these redundant deformation forces in piercing would prove valuable indeed. There remains a question to what overall extent they can be controlled, due to the very nature of the process. But if they can be better regulated in a practical manner, then the ultimate reward might be greater operating efficiency, higher yields, and somewhat less rigid steel specifications.

Ross McLaren: This work is a very interesting study of the metal movement during piercing. I feel that a great deal of study should be made of the findings as they cannot be interpreted by a quick analysis. We can all thank Spang-Chalfant for making the results available for all of us to study. Further work should be done along this line, and possibly this article will foster increased experimentation. There are a few points I would like to have cleared up as follows:

1. What feed angle or angles were used?

2. Were the three design points the same for the seven degree and four degree roll or was there a different point for each roll?

3. In the calculation of the plug surface, what is meant by increment of advance along the point cavity? Is this the calculated feed per revolution? If so, how did you handle slippage which changes the theoretical feed? Slippage also changes due to the various factors—wall produced, the plug design, draft used, location of plug in mill, etc.

4. Some curves are stopped off before the tube is completely formed; thus it is hard to draw the correct conclusion in these cases. Take the curves of area reduction, the increase of area on the seven degree and four degree roll with the accelerated plug never levels off. The cross-section on the seven degree roll seems to level off at sixty per cent of the original area, but the filament reaches forty-seven per cent and forty per cent, then increases to fifty-eight per cent and forty-seven per cent, but has not leveled off. The cross section area on the four degree roll is never shown leveling off, and the filaments reach seventy per cent and sixty per cent, then increase to seventy-five per cent and sixty-five per cent, but are never shown leveling off.

The reason I raise this question is due to the fact that I think there is possibly an upsetting action somewhere along the pass, and if the curves leveled off we could see that. Not leveling off we cannot pick out whether there is an upsetting action or not.

There could be a case of the defective filament making different areas as we project along the pass but I do not think that the defective filament would affect a cross sectional area of the tube itself.

For the further experimental work needed, I would like to make the following suggestions:

1. A study of what happens as the front end covers the roll and the last end leaves the roll. It is during this period that slippage is varying with each new roll contact. When the roll is completely covered with metal, the slippage is relatively constant as shown by the feed marks. Does this cause the front and back and inside diameter defects in tubes of sensitive piercing steels such as the stainless types, etc.?

2. Any study of defects will require the use of material for piercing which will rupture due to ovaling, at the same relative degree that the various steels do, since some of the inside diameter defects are caused by rupture from the ovality produced on the inlet end of the roll.

3. A study of the effect of increased increment of feed, as is possible on a cone mill, in relation to defects produced on barrel mills where the increment of feed is negative. What is most important in the elimination of defects, is it increased increment of feed, or is it the lack of twist in the billet? We cannot have both. If we fix up the feed to compensate for the elongation, we upset the twist.

A. B. Capron: Mr. Holmquist's paper is a very clear explanation of a means of investigating phenomena about which there is little known. Everyone in the seamless tube industry will agree that a piercer, be it Mannesmann type, cone type, or any combination thereof, does as severe a job of punishing steel as any testing machine, and we are all interested in eliminating, to as great a degree as possible, the non-essential deformations which Mr. Holmquist highlights.

In reading over Mr. Holmquist's paper, I hopefully looked for information which, when compared with our present practices, would immediately minimize these redundant deformations, but I then realized that his paper is confined to an illustration of a type of investigation which each of us will have to perform in much greater detail and on our own type of piercer to ferret out these bad points. There are many variables in the setup of a piercing mill which his investigation does not cover, and the effect of each of them will have to be measured before data leading to the establishment of the perfect piercer pass design can be assembled. Piercer point position, draft, and shoe space will all

have to be taken into account for all affect the displacement of metal during the piercing operation.

I suppose all of us have at one time or another made experiments with special billets containing filaments or segments of dissimilar metals in an effort to know what happens during the piercing operation, but to do a complete job on steel billets is a terrific task. The wax billet method outlined by Mr. Holmquist will certainly show the trend of effect of changes in setup, and as he points out, that trend should be the same as would be found in piercing steel even though the magnitude might be different. When these trends are definitely determined by consistent results over a long series of tests, the setup changes can be applied one at a time to the full size piercing mill to check the data observed on the wax billet experiments. I am afraid that the average hot mill superintendent will be "from Missouri" until he can be shown on his own piercer that setup changes which worked well on wax billets also improve his operation on steel billets.

I suspect there will be a rash of model piercing mills in the seamless tube industry as a result of Mr. Holmquist's paper. The eager beavers in our organization are already planning an expanded program along the lines which Mr. Holmquist has set forth in his paper. I can see right now he is responsible for a lot of experimental costs on our books in the next year.

J. L. Holmquist: Mr. McLaren commented on certain curves in the paper on the billets pierced with the accelerated rate type point which demonstrates some effects that are not very comprehensible. As a matter of fact I view these particular results with a great deal of reservation, and on that account I have to say that it is simply a matter of doing more work to get the matter clarified.

He also asked a question about the utility of this method for indicating whether or not in so-called sensitive steels, certain defects were due to the redundant deformations and I would like to say that the wax billet method would have no utility at all in my estimation for evaluating the piercability of a given grade steel. The method is inherently suited for revealing the magnitude and distribution of deformations that result from a given type of equipment or setup of same, but whether or not a given material would be capable of withstanding those deformations without rupture; that is outside the province of this method.

On the other hand, the type of investigation for which it should be well suited is the comparison of different types of equipment. If you have a cone mill or disc mill or Mannesmann type mill, or whatever you have, to determine the characteristics of that equipment with respect to the magnitude and distribution of the redundant deformations, certainly I believe the wax billet method would be very helpful.

M. D. Stone: I should like to ask Mr. Holmquist, with reference to technique, what he thinks of the relative merits of the wax method as compared to the laminated lead disc method, etc. Many years ago H. Tresca in Paris, carried out a very fundamental investigation of this type on die forging and extrusion, using various techniques, including lead discs, primarily, which was thought to more accurately duplicate the flow of hot steel.

J. L. Holmquist: We have not used lead. One of the attractions of wax is it is so easy to make. Billets containing filaments, colored wafers and so forth with lead would be much more difficult to make.

M. S. Gettig: We wish to congratulate Mr. Holmquist and the National Supply Company on a very excellent beginning to resolve the "so-called" mysteries of piercing process into their proper niche and evaluate their effects so that piercing process can be removed from the category of an art and brought into the realm of a well controlled scientific process. This paper appears to the best of our knowledge, to be the start of the most comprehensive examination ever made of the piercing process or at least the most comprehensive ever brought to public attention. As Mr. Holmquist has stated; this paper deals with only one specific problem and it is hoped that such work may be continued to a successful conclusion so that all of the problems involved in rotary piercing may be solved or at the least more accurately controlled.

There are several questions we have in mind regarding the conclusions which have been drawn and we would be happy if Mr. Holmquist would care to enlighten us further on them.

The first question deals with the statement where it says that the longitudinal strain is the same for all shells. We note that Mr. Holmquist has qualified the statement at the end of the appendix by saying that this is only a close approximation. Assuming, however, that the strains were exactly the same, it then appears to us that the distances between the light and dark wafers in Figure 23 would be exactly the same at any point on the wall of the billet after piercing. We are wondering if this was found to be true.

Our second question deals with the statement that basic deformations would remain the same regardless of the method of piercing. Although Mr. Holmquist has gone to some length in explaining the theory from which this conclusion is drawn, we have been unable to reconcile in our mind how these basic deformations would remain the same in a straight thrust piercing operation such as a piercing press as compared to a three-high rolling mill, such as we imagine the piercer to be, wherein the two conical piercer rolls are the top and bottom roll with a floating third roll in between which is the piercer point.

In closing, I hope that this may only be the first of a series of papers aimed at solving many other problems in rotary piercing.

J. L. Holmquist: Mr. Gettig has pointed out that a consequence of the same longitudinal strain (elongation) in all shell elements of the pierced billet would be that the distance between the light and dark wafers should be the same across the wall thickness of the pierced billet. A check on the longitudinal sections shown in Figure 23 confirms his expectation. The check is most easily made on Specimen I of Figure 23. This specimen shows clearly on the inside surface, two dark circumferential bands corresponding to two of the dark wafers. If the width of these dark bands is compared to the width of the corresponding dark wafers at the outer surface, they are found to be quite closely the same.

The curvature revealed at the boundary between the

light and dark wafers by the longitudinal sections shown in Figure 23 demonstrate that the longitudinal shear is not constant across the wall thickness. If the longitudinal shear was constant across the wall thickness, the boundaries would be slanting straight lines. In the wax shells shown in Figure 23, the longitudinal shear is a maximum at the inner surface and a minimum at the outer surface. Why should the longitudinal shear be greater near the inner surface of the shell than near the outer surface? This question has not received any thorough-going study as yet but the following thought comes to mind on brief consideration.

The origin of longitudinal shear is the parallel but opposing axial forces imposed on the workpiece in progressing through the mill. One force is the tractive force exerted on the outer surface by the rolls; the other force is the thrust of the piercer bar acting on the center material. Static equilibrium requires that these forces be equal and opposite. We now consider the shear stress resulting from these forces. Stress is force divided by area so we consider the area on which the force acts. We consider now one wafer. If we draw a circle of radius r, large enough to come close to the outer surface, the area of this imaginary surface is the circumference of the circle, $2 \pi r_1$, multiplied by the thickness of the wafer. The shear stress is the piercer bar thrust divided by the above area. If now we draw a circle of smaller radius r_2, the area of the imaginary surface defined by it is $2 \pi r_2$, multiplied by the thickness of the wafer. The shear stress on this surface is the piercer bar thrust divided by the area, but since this area is smaller, the shear stress on it is higher than on the surface defined by the circle of larger radius. The amount of shear deformation will be larger the greater the shear stress producing it so it follows that the longitudinal shear deformation would be least at the outer surface and increase in the material as we approach the axis. This is consistent with what is observed to occur on the wafer type billets.

Mr. Gettig also comments on a seeming difficulty in accepting the principle that the basic deformations are independent of the piercing process. It might be helpful to consider the matter in more general terms. In any change of shape of a body certain essential deformations are involved. To convert a cube to a sphere, for example, there would be certain essential deformations —these are what have been called the basic deformations in the paper. In this case it might be rather difficult to identify and describe the essential deformations, nevertheless they exist. Fortunately, in converting a solid cylinder to a hollow one, we are dealing with a simple case and it is easy to see what the essential deformations are. But to return to the example of the cube converted to a sphere, it obviously would not make any difference how this was done, the cube could be forged under a steam hammer or squeezed in a closed cavity die, and the essential deformations would be the same because they depend only on the geometrical relation between the cube and the sphere.

In the appendix a method is developed for working out the position, size, and shape which the filaments will have after piercing when the filament type of billet is pierced. This method is based on geometrical considerations only; it does not take into account any method of piercing. The results obtained by this method are in excellent agreement with experiment as can be checked by comparing Figure 28b with Figure 10a and Figure 10b.

AID DEFENSE

MORE SCRAP TODAY . . . .

MORE STEEL TOMORROW.

GET IN THE SCRAP TO KEEP STEEL COMING.

NON-FERROUS SCRAP IS NEEDED TOO!

DEVELOPMENTS IN ELECTRICAL DRIVES FOR STEEL MILL APPLICATIONS

By W. R. HARRIS

Manager Metal Working Section

Westinghouse Electric Corp.

East Pittsburgh, Pa.

. . . . with the selection of larger motor sizes for main drives, increased capacity will be obtained from rolling mills . . . .

▲ THE electrical drive equipment forms an integral part of any modern mill installation and as much thought and care in its selection is as necessary as is given to the mechanical equipment and the layout of the operating facilities. This paper will discuss a few of the drives recently installed, or soon to be installed, in the Philadelphia area. These are:

1. The revamp of the 56-in. four-stand tandem cold mill at the Sparrows Point plant of Bethlehem Steel to a five-stand tinplate mill.
2. The layout of the main drive equipment for the 45-in. universal slabbing mill to be installed at the Fairless plant of the U. S. Steel Co. An essentially duplicate drive is also being built for the Great Lakes Steel Corp.
3. The drive layout of the 80-in. hot strip mill at the Fairless plant of the U. S. Steel Co.

THE SPARROWS POINT TANDEM MILL REVAMP PROGRAM

The addition of a fifth stand and a new reel drive to the 56-in. tandem cold reduction mill at Sparrows Point is interesting because of the unusual electrical problems, the construction difficulties involved, and the short period of 24 days in which the entire change was accomplished. Table I gives the pertinent information on the drive. As a four-stand mill the maximum speed was 3020 fpm and the total connected horsepower including the reel was 11,600. Single armature twin drives with off-setting gears were used on stands 3 and 4.

As a five-stand mill the maximum speed is 4125 fpm with a total connected horsepower of 15,300. The single armature twin drive arrangement was retained for the fifth stand and the motor speed was selected to give a duplicate off-setting gear of the original No. 4 stand. After calculation of several expected rolling schedules, 3500 hp was chosen for the fifth stand and 800 hp for the reel drive.

The resultant five-stand mill is typical of average modern practice. The average value of horsepower per 1000 fpm for tinplate mills varies between 2600 and 4400, with most mills in the range of 3500 to 4000. The Sparrows Point plant has 3700 hp per 1000 fpm which is typical of modern practice. Several of the modern tinplate mills have been designed with maximum operating speeds of 5000 fpm or more for light schedules and the average maximum speed of all five-stand mills installed since the war is about 4400 fpm. Because of horsepower and/or rolling limitations, none of these mills has operated consistently at much above 4000 fpm and the average operating speed for all schedules is probably in the neighborhood of 3500 fpm. Here again

TABLE I

Stand	Hp	Rpm	Armatures	Gear ratio	Roll rpm	Fpm 21-in. rolls
1	2500	70/175	SA	Direct	70/175	386/964
2	2500	130/260	SA	Direct	130/260	716/1432
3	3000	200/450	SAT	42-46	183/411	1010/2265
4	3000	200/500	SAT	46-42	219/548	1205/3020
5	3500	300/685	SAT	46-42	329/750	1810/4125
Reel	800	200/800	DA	Direct	.....	.....
	15300					

No. 1 MG Set: 2 — 4000-kw generators. Stands No. 1 to No. 4.
No. 2 MG Set: 1 — 2800-kw generator. Stand No. 5.
1 — 640-kw generator. Reel.

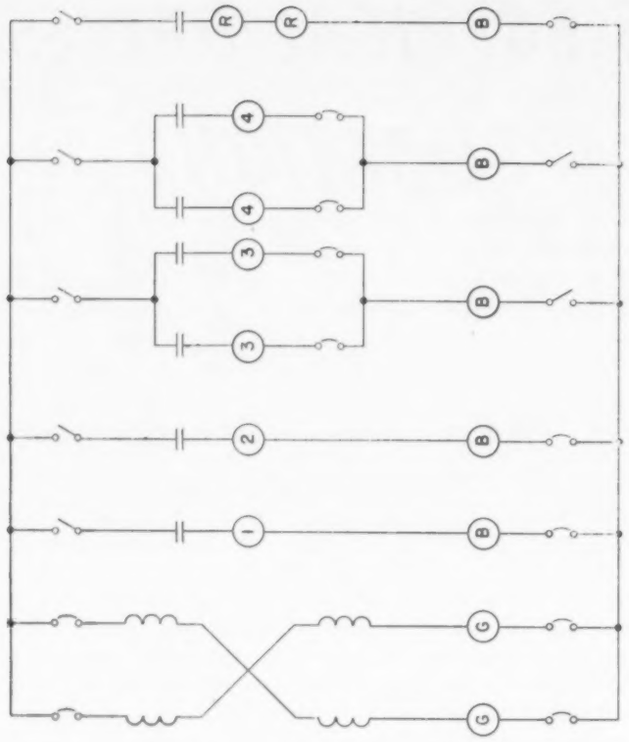


Figure 1 — Electrical arrangement of original four-stand mill utilizes common bus control scheme.

this mill is capable of operating speeds which are typical of modern practice.

Figure 1 shows the electrical arrangement of the original mill which enjoyed one of the best reputations in the country. All stand drives have IR drop boosters and utilize a common bus control scheme. It would have been possible to extend the common bus to take care of the fifth stand and the new reel drive by adding additional generating capacity to operate in parallel with the existing units. After careful study it was decided that it would be advantageous to use an individual generator control system on the fifth stand and the new reel. This was particularly desirable from a changeover standpoint, since it meant a minimum of disturbance to the existing installation and allowed better freedom of choice in running the new bus work and control circuits required. This, combined with the elimination of the large IR drop boosters for the new stand and reel, the possibility of widening the speed cone by reducing the voltage independently on the fifth stand, and a somewhat simpler control scheme resulted in the layout shown in Figure 2. Here the common bus system for the four stands is left undisturbed except for removal of the reel drive with its associated booster and control circuit. A new motor-generator set was supplied to supply power to the fifth stand and the reel. The existing generator voltage control for the old mill was scrapped and a modern individual generator type of control substituted. With this system a master reference bus is used against which the voltage of each generator system is balanced. The complete drive then really becomes a two-stand mill with four separate drives on the first stand. IR drop compensation through booster generators is retained on the first four stands. IR compensation through the stand generator is used on the fifth stand. This arrangement has been found to be very satisfactory and the mill crews feel that the original excellent operating characteristics of the mill have been retained.

The complete mechanical and electrical changes for this mill were made in twenty-four days. Figures 3 and 4 show a construction photograph two days after the mill was shut down, and the mill essentially complete 19 days after the shutdown. Construction difficulties were relocation of the oil cellar, relocation of several panels, and miscellaneous piping and wiring about the mill location. The mill personnel are to be congratulated on a carefully planned and a well executed job. It is difficult to tell—by looking at either the mill or the motor room—that a change has been made.

There is always considerable pressure to get a new drive in production and at times necessary performance checks are eliminated. On this particular drive it was mutually decided that regardless of pressure, the electrical drive would be thoroughly checked and adjusted before being turned over for operation. This procedure payed off handsomely. The mill was started at 10 a.m. one day and until 7:30 a.m. the next day rolled 1500 tons of steel with only minor interruptions. Since that time the mill has made an enviable operating record and has become one of the best mills in the country on an average tinplate output basis.

80-IN. HOT STRIP MILL

The finishing stands of the 80-in. hot strip mill at the Fairless works is unusual because of the large power concentration and the arrangement of ignitron rectifiers to supply the direct current power. Figure 5 is a simplified diagram of the layout and the power arrangement of this mill. The six finishing stands are driven by a total of 29,000 hp in direct current motors. Six 4000-kw ignitron rectifiers form the direct current power supply. The mill will use three separate bus sections with two 4000-kw ignitron rectifiers in parallel supplying each section. The voltage of these rectifiers will be maintained

Figure 2 — Electrical arrangement of revamped mill shows combination common bus and individual generator drive.

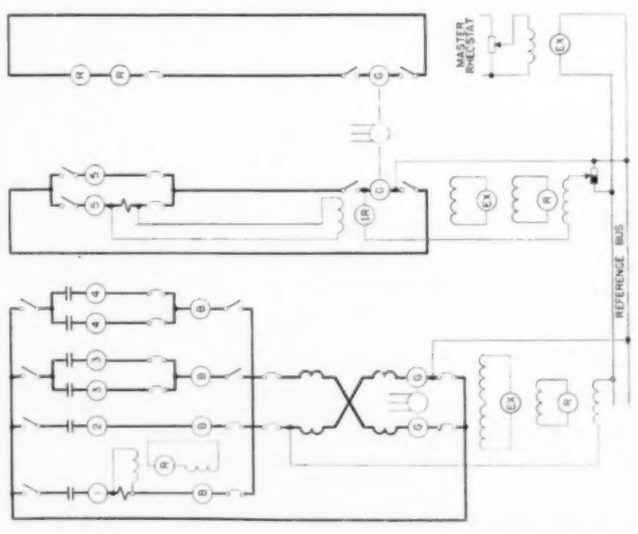


Figure 3 — Construction photograph shows status two days after mill was shut down.

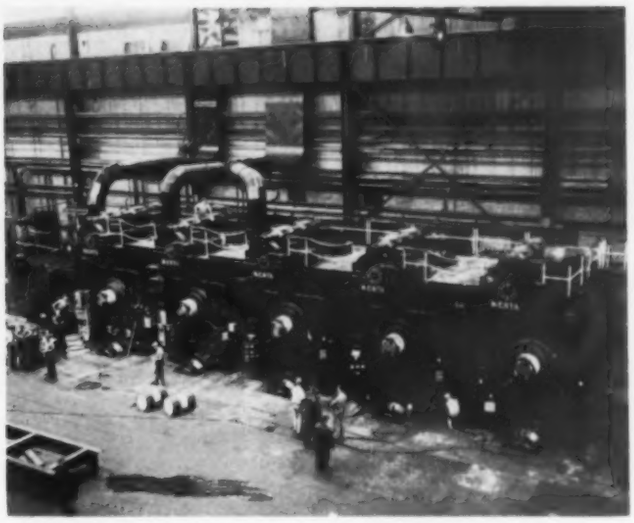


Figure 4 — Illustration shows the tandem mill essentially complete 19 days after shutdown. New stand is on left end.

very closely by means of magnetic amplifier voltage regulators.

The voltage output of an ignitron rectifier is directly proportional to the a-c input voltage and the regulation and fluctuations in the a-c voltage will directly affect the d-c voltage. Therefore the regulation of the a-c line, and the regulation through the rectifier components, as well as the maximum expected load, must be carefully considered in selecting the transformers and layout of the voltage regulation arrangement. If all rectifiers were on a common bus, a slight variation in d-c bus voltage with load would not be harmful. Many of the older mills are operating in this manner, some with as much as 5 per cent voltage variation in bus voltage no-load to maximum load. However, when the bus is separated into three separate sections it is mandatory that the voltage of each section be carefully matched to avoid rolling difficulties. The calculated loads on this diagram indicate the minimum and maximum kilowatt load on each bus section with the expected rolling schedules. The total variation is from 62½ per cent to 175 per cent of the rectifier full load rating. The maximum total mill load is expected to be about 35,000 kw which for a typical schedule will build up and fall off as indicated on the load diagram. On the Fairless mill, the expected a-c voltage variation will be about 5 per cent. The no-load to full load regulation of the rectifier will be 5 per cent and the rectifier transformer is designed to give 100 per cent d-c voltage at full load on normal tap setting. With the proper tap setting and regulator adjustment it will be possible to maintain flat voltage regulation at the expected overloads.

Normally all three d-c bus sections will operate at the same voltage. Transformer taps are provided so that if desired the buses can be operated at different voltages. The rated voltage is 700 and an auto-transformer is provided for 750, 582, 466, and 350 volts on a full load basis.

In order to provide a stable low voltage for jogging and for turning over the motors at low speed the voltage regulating system is designed to provide a minimum voltage of 30.

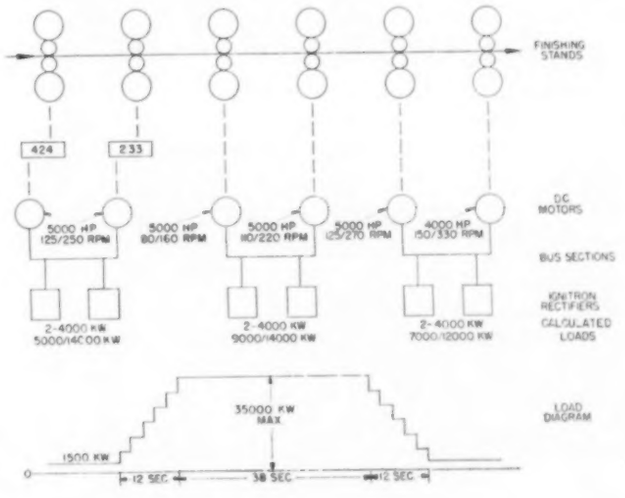
12,000-HP SLABBING MILL

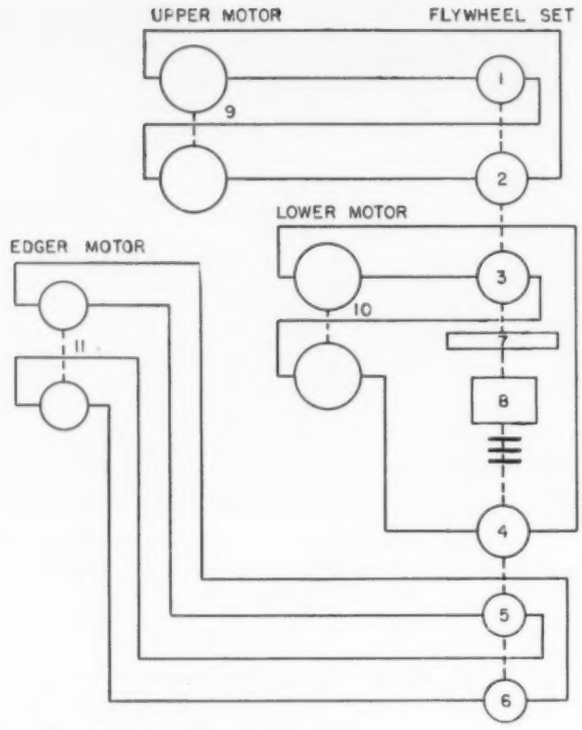
The universal slabbing mill at the Fairless works of the U. S. Steel Co. will have the most powerful drive ever used for a mill of this type. The horizontal rolls will be driven by a 12,000-hp twin motor drive consisting of two 6000-hp, 40/80-rpm double armature reversing motor. The total maximum momentary torque capacity will be 4,330,000 lb-ft which is 20 per cent higher than has been used before.

The mill will also have the most powerful vertical roll drive which has ever been built. The drive is a 4000-hp, 60/150-rpm, double armature reversing type motor which is 33.3 per cent larger than has been used before. This motor will drive the vertical rolls through two fixed right angle gear units and vertical universal spindles to connect the gear units to each vertical roll.

Figure 6 shows schematically the layout of the motor armatures and the power supplying direct current generators. Four 2500-kw direct current generators will

Figure 5 — Arrangement of main drive motors and ignitron rectifier power supply for the 80-in. hot strip mill at the Fairless works.





UNITS 1,2,3,4 – 2500 KW GENERATORS
UNITS 5 & 6 – 1750 KW GENERATORS
UNIT 7 – 65 TON FLYWHEEL
UNIT 8 – 8000 HP INDUCTION MOTOR
UNITS 9 & 10 – 6000 HP DOUBLE ARMATURE REVERSING MOTORS
UNIT 11 – 4000 HP DOUBLE ARMATURE REVERSING MOTOR

Figure 6 — Main connections of 16,000-hp slabbing mill drive.

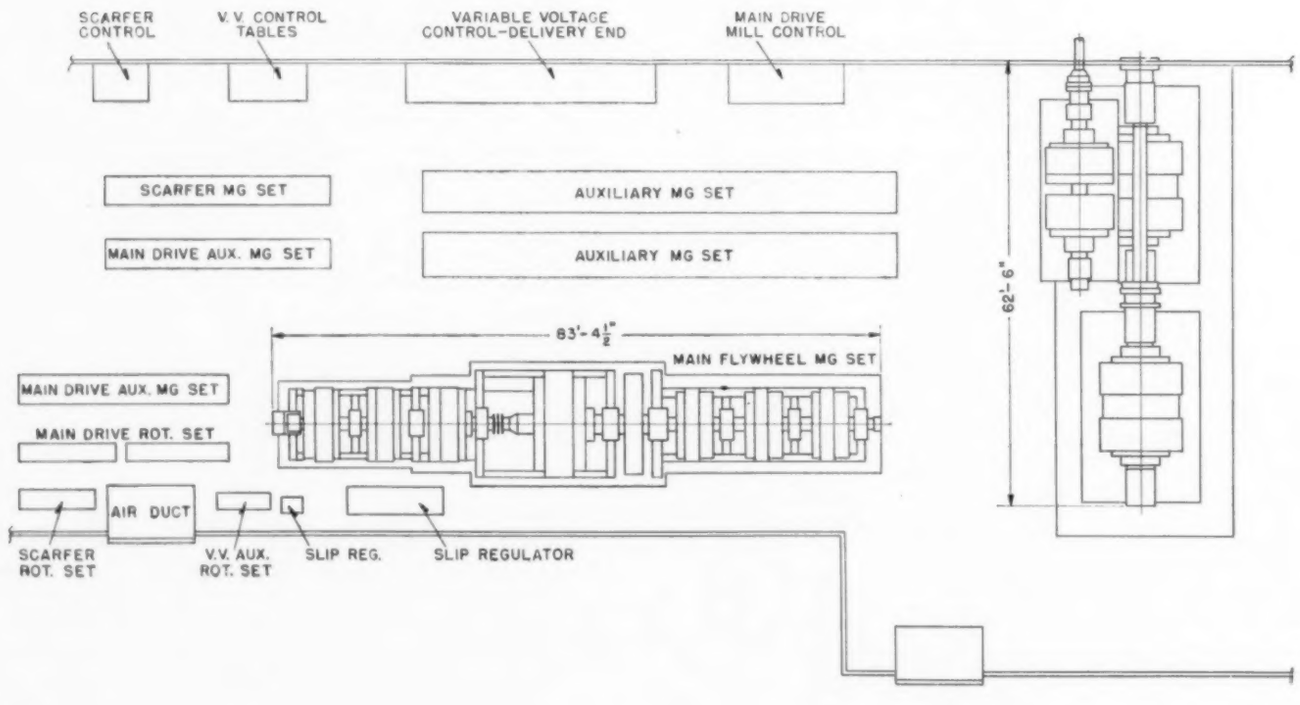
supply power to the horizontal roll drives, two 1750-kw generators will supply power to the vertical roll drives, and the set will be driven by an 8000-hp, 514-rpm, wound rotor induction motor with a 65-ton, 215,000-hp second flywheel.

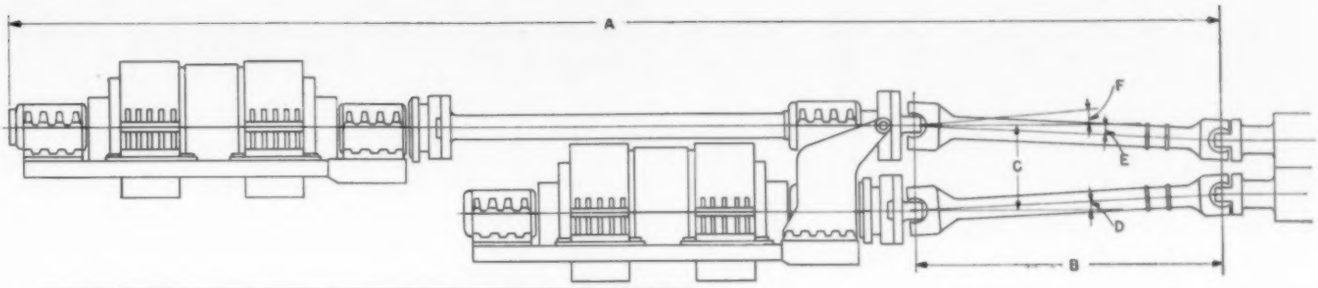
The d-c machines are connected in three separate series sandwich loops. One circuit is for the upper horizontal roll drive, one circuit for the lower horizontal roll drive, and one circuit for the edger motor drive. This type of arrangement has several advantages over the more conventional circuit where all generators and motors are operated in parallel. The load balance arrangement is considerably simplified, fewer circuit breakers are required, short circuit currents are less and the direct current bus arrangement does not have to be as heavy.

Figure 7 is a simplified layout plan of part of the motor room housing the main drive motor-generator set and motors. The horizontal roll drive extends 62 ft-6 in. from the motor room wall. The net weight of this unit complete will be 1,250,000 lb. Each 6000-hp motor will have two 3000-hp armatures mounted on a common shaft which will weigh 215,000 lb. The main motor-generator set is one of the longest units that has been built to date. It has a total length of 83 ft-4½ in. The 4000-hp double armature edger motor will be mounted approximately 33 ft above the motor room floor. Since the distance between the center line of the edging rolls and the main rolls is only approximately 8 ft the edger drive will overhang the main roll drive as indicated by the plan view.

Figure 8 shows the total length of several large twin motor drives including spindles which have been recently installed. Angle D shows the angle which the lower spindle makes with the horizontal, and angles E and F show the spindle angles with the top roll lowered and raised. For the average rolling condition the upper spindle angle is of course approximately the same as the lower spindle angle. It will be noted from this illustration that the new drive, while it will be the

Figure 7 — Arrangement of motor room for 16,000-hp slabbing mill drive.





	A	B	C	D	E	F
45" MILL – E.T.	80'–7 3/4"	31'–1"	94"	2.5°	6.4°	5.2°
44" MILL – SOUTH	104'–0"	31'–0"	83 1/2"	—	3.75°	2.67°
54" MILL – SOUTH	98'–0"	25'–0"	83 1/2"	2.5°	4.0°	5.0°
45" MILL – H'STD	81'–2 1/2"	31'–1"	94"	2.25°	5.17°	—
160" MILL – H'STD	86'–0 3/4"	36'–0"	94"	3.17°	4.25°	—
45" SLAB.–BLOOM. MILL–FAIRLESS	95'–9 1/4"	30'–0"	94 1/4"	2.00°	6.25°	6.15°

Figure 8 — Overall length and spindle angles of several large blooming and slabbing mills.

largest in existence, does not exceed previous practice as to total length, length of spindles, and spindle angles.

In addition to the above the drive will have the following features:

1. Dynamic braking for bringing the flywheel set to rest.
2. Oil lift for the flywheel bearings.
3. Totally enclosed forced ventilated main machines.
4. Laminated frames for the main generators.
5. Circulating oil lubrication system for all main bearings.
6. Thrust bearings and oscillation dampers on the horizontal roll drive motors.

This mill can be arranged for blooming mill operation by removing the vertical rolls.

There is also being furnished an 8000-hp, 65/130-rpm, single armature twin reversing drive for a 40-in. blooming mill. The total maximum torque of this unit is 1,780,000 lb-ft which is less than one-half of the torque capacity of the slabbing mill drive. The power supply for this mill will be from 3 - 2500-kw, 700-volt, 514-rpm d-c generators, duplicate of the units on the slabbing mill. The set will be driven by a 6000-hp wound rotor motor with a 185,000 hp-sec flywheel.

SUMMARY

The success of many of the large, high production rolling mills and complex strip processing lines depends to a large extent upon the proper characteristics of the main drive machines and upon the smooth functioning of the automatic control and regulating equipment. The preceding has briefly "hit some of the high spots" of recent practice in drives and regulating equipment.

DISCUSSION

PRESENTED BY

H. H. ANGEL, Electrical Engineer, Construction and Engineering Department, Bethlehem Steel Co., Bethlehem, Pa.

F. O. SCHNURE, Superintendent, Electrical Department, Bethlehem Steel Co., Sparrows Point, Md.

W. B. SNYDER, Assistant Manager Steel Mill Division, General Electric Co., Schenectady, N. Y.

W. R. HARRIS, Manager Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

H. H. Angel: In reference to the selection of 12,000-hp for the horizontal roll drives, you indicated previous drives employed 10,000 hp and I do not think you made it clear why the larger horsepower was used on the two installations. Is it because of a heavier rolling schedule, or is it based on allowing a leeway for future heavier rollings?

F. O. Schnure: It would be "carrying coal to Newcastle" to repeat Mr. Harris' statement as to the success of the change-over of our four to a five-stand cold strip mill. The original four-stand mill had a fine operating record from all viewpoints and particularly that of control. The equipment and wiring were in fine order. The addition of the drives for the fifth stand involved the relocation of the main switchboard and the re-routing of practically all the conduit and wiring in order to provide space for the new motor foundations. However, regardless of our apprehensions as to the outcome, the performance and appearance of the revamped mill certainly has met, and perhaps exceeded that of the original.

A job of this nature requires careful scheduling of activities. All crafts of the construction forces cooperated to the common end. The immediate successful operations of the mill was largely due to the insistence of the engineers who designed the control, that it be thoroughly checked and "tuned up" before placing in operation.

W. B. Snyder: The changing over of the cold strip mill in twenty-five days was a remarkable job. There is one point that the author has not mentioned and that I think is quite important. That is, the segregation of the d-c supply greatly reduces the magnitude of the d-c short circuit current. I think Mr. Harris will agree that most of the hot strip mill installations are theo-

retically unsafe. That is, the actual currents that may flow on short circuit are probably well beyond the interrupting capacity of the breakers now in use, and it has been most fortunate that short circuits of this magnitude have practically never occurred. There have been one or two cases of severe short circuits where the hot strip mill bus has fallen down on the motor floor, but fortunately these have been extremely infrequent.

The slabbing mill installation Mr. Harris has described is very interesting. Since he is supplying his edger motor from a separate generator, I suspect that he is now getting his draft compensation by voltage, which we feel is a step in the right direction. While this usually involves a more expensive generator than would be required if draft compensation is obtained by motor field, the reduction in motor field range provides a better balance of accelerating characteristics between the main motor and the edger motor, and thus tends toward better mill operating characteristics. We have been advocating this method for many years.

It appears that the Philadelphia area is going to retain the palm for having the highest torque twin drive motor. At present, the record is held by an 8000-hp, 30/75-rpm drive on the 206-in. plate mill at the Lukens Steel Co., which has been in service for about a year, but the honor will pass to the drive which goes into service at the Fairless works.

W. R. Harris: In answer to Mr. Angel, the horsepower on the Great Lakes and the Fairless slabbing mills was increased to meet heavier projected rolling schedules and to obtain higher tonnages. It is expected that somewhat heavier drafts than has been the normal practice will be taken.

Mr. Snyder's remarks on the short circuit current of large installations are in order. Although some installations, by calculation, are unsafe there has been no undue difficulty with them. This is due to the fact that a dead short circuit is seldom obtained.

The bus stresses due to very high short circuit currents can be considerable if the busses are mounted side by side with close spacing. The modern practice is to separate the positive and negative busses as far as possible in order to prevent such stresses.

On the slabbing mill, the edger motor has sufficient range by shunt field control to obtain draft compensation. A current limit arrangement is provided for the edger generators so that if draft compensation is not set correctly the generator voltage will be changed to take care of it.

Plan to Attend

1953

AISE SPRING CONFERENCE

HOTEL STATLER

BUFFALO, NEW YORK

MAY 18, 19

AND

1953 ANNUAL CONVENTION

HOTEL WILLIAM PENN

PITTSBURGH, PA.

SEPTEMBER 28, 29, 30, OCTOBER 1

INJECTION OF OXYGEN-REFORMED NATURAL GAS AND FUEL OIL INTO THE BLAST FURNACE

By DR. JULIEN O. RAICK
Ingenieur Civil des Mines, A.I.Lg
Brussels, Belgium
and
JAMES E. BRASSERT
Executive Vice President
H. A. Brassert & Co., Inc.
New York, N. Y.

. . . . with the use of existing blast furnace facilities plus some minor equipment and an oxygen plant, a radical change in blast furnace operation is proposed which would double the output of existing blast furnace units and decrease coke rates to about one-half present values . . . .

▲ THE art of smelting ores in the blast furnace has changed very little over the last 100 years. Although radical changes in the size of the units and in the design and construction of blast furnace plants have taken place, the manufacture of molten metal is still practiced with either charcoal or, more usually, coke, as the sole reducing and heating agent.

In this paper, a method of smelting is presented that can double the output of the blast furnace with a decrease in coke ratio to about one half its present value. This process can be accomplished with the use of natural gas, which costs 4 to 45 cents a million Btu, as against coke, which costs 40 to 75 cents a million Btu. It can also be accomplished with fuel oil. Undoubtedly, many of our readers have at one time or another thought about putting some gas in the furnace and seeing what results would occur. During the past three or four years, we have worked out a comprehensive thermodynamic analysis of the whole blast furnace process, to enable us to find what gases to inject, and where, how, and at what temperatures and pressures to inject them. We are now in a position to predict with great accuracy what happens when either natural gas, fuel oil, or any hydrocarbon-containing material is substituted for coke in the furnace.

Because of the high cost of undertaking new types of blast furnace operation, we believe that a thoroughly sound thermodynamic analysis is the most important and least expensive guide to any large-scale experiments of the future, and accordingly, a great deal of what we are saying in this paper depends on the reliability of our analysis and its successful prediction of furnace performance under varying conditions. To check our methods, we have applied them to a number of normal coke-burning furnaces in great detail. Starting with only the burden analysis, the pounds of carbon burned at the tuyeres per minute, the CO/CO_2 ratio, and the top gas temperature, we have predicted within 2 per cent, the actual iron production, the coke consumption per ton of iron, the blast temperature, the slag volume, and many other operating conditions. In every case, if we know the costs of the various burden materials and fuels, we can calculate the economics of any injection process.

What can we do to improve the economics and productivity of the blast furnace? There has been much speculation and experimentation on dry blast, wet blast, high top pressure, oxygen-enrichment of the blast and, most important of all, burden preparation. Results to be expected from each of these measures depend on local conditions, and in many cases the surplus economies do not justify the additional capital investment. Most of us are agreed, however, that correct burden preparation can and does improve production by giving better gas-solid contact, lower coke consumption and, consequently, greater iron production.

We are all conscious of the present increasing cost of coke delivered to the furnace, caused in no small measure by the enormous investment in the coke plant, and the ever increasing cost of transporting and mining coal. An improved burden preparation and gas-solid contact affects the thermodynamic equilibrium of the furnace and decreases the coke consumption by lowering the CO/CO_2 ratio in the top gas. However, it is almost certain there is a practical limit of about 1.6 to this ratio which has already been reached in some cases, for example, in the excellent practice at Fontana. When the burden preparation approaches the optimum, the reducing capacity of the gases produced per pound of carbon burned at the tuyeres reaches its maximum. This reducing capacity is not yet sufficient to reduce the corresponding iron, and we would not be able to produce pig iron in the blast furnace at all economically if it were not for the fortunate fact that additional reducing capacity is automatically added by the solution loss of carbon in CO_2 according to the equation $C + CO_2 = 2\ CO$. Although the carbon consumed in this reaction is only 4 per cent of the coke consumption in a typical calculation, the solution loss reaction is very endothermic. This means that heat has to be supplied for this reaction by carbon which is charged from the big bell, heated up through the stack, and burned at the tuyeres to furnish heat-carrying gases. These gases pass up the furnace with considerable loss of high-temperature energy due to convection and radiation, and finally give off the necessary heat in the stack in the region where the solution loss reaction is taking place. The additional heat consumption due to these operations corresponds to about 22 per cent of the coke consumption in the same calculation. This means that even when the burden preparation is at its optimum, about 26 per cent of the coke consumption could be removed by eliminating the solution loss reaction. One reason this figure is so high is that heating a pound of carbon by, say, 100 F in the furnace consumes more Btus than heating any of the other compounds present in the furnace, including Fe_2O_3.

Since injection of reducing gases obtained from natural gas or fuel oil into the shaft brings in no slag material but, on the contrary, brings in additional heat to cover the shaft requirements, there is an additional saving due to decreasing or eliminating the solution loss. This saving may amount to another 25 per cent of the coke. With the optimum burden preparation, the total estimated savings in coke consumption per ton of iron due to injection of reducing gases is in the neighborhood of 50 per cent, and still greater savings can be ultimately expected with high top pressure operation.

When we calculate the production of a furnace according to our methods, we base our calculations on the number of pounds of carbon burned at the tuyeres per unit of time rather than on the coke charged. Accordingly, we divide the total number of pounds of carbon burned per day at the tuyeres by the pounds of carbon per ton of iron to obtain the daily production of iron. Since the rate at which carbon is burned at the tuyeres is a constant in the calculations, determined by statistical evaluation of the rates of combustion in many large furnaces of different sizes, it follows that lower coke ratios mean higher production.

It is easy to visualize a blast furnace in which we are thus able to replace a large percentage of the coke volume with iron ore, and which will produce more iron per day by virtue of the heavier burden. Clearly, the friability of the remaining coke will limit the increase in weight of the burden, but it is apparent that, in view of the excellent results at Fontana with a small and weak coke and a coke ratio of only 1300 lb, we can still go a long way before we reach this limit. When operating the furnace with fine ores, it will be almost essential to decrease the pressure differential through the stock column and keep the furnace open by agglomerating or pelletizing the charge. It has already been clearly shown that a pelletized burden gives excellent economies in coke consumption as compared with a normal burden of Mesabi ore. With decreased coke ratios, agglomeration or pelletizing of fine ores will become essential.

Figure 1 shows a proposed installation in which reformed natural gas is to be injected into the shaft of a 25 ft 6 in. furnace. Note that the installation of the equipment to perform this work is relatively simple and that almost no changes are required in the lines of the conventional coke-burning furnace.

For very substantial reasons, the discussion of which is beyond the scope of this paper, it has been decided to inject the gases into the furnace at the point where the slag becomes molten. The best reducing gas consists of CO and 25 per cent or more of H_2. We have found in our laboratory that this gas is far more active than pure CO, and that this percentage of hydrogen increases the rates of the reduction reactions through a wide range of temperatures. Our findings in this regard have been confirmed by other investigators. It so happens that reformed natural gas, after it is mixed with the combustion gases ascending from the tuyeres, provides a furnace gas containing just about 25 per cent of H_2.

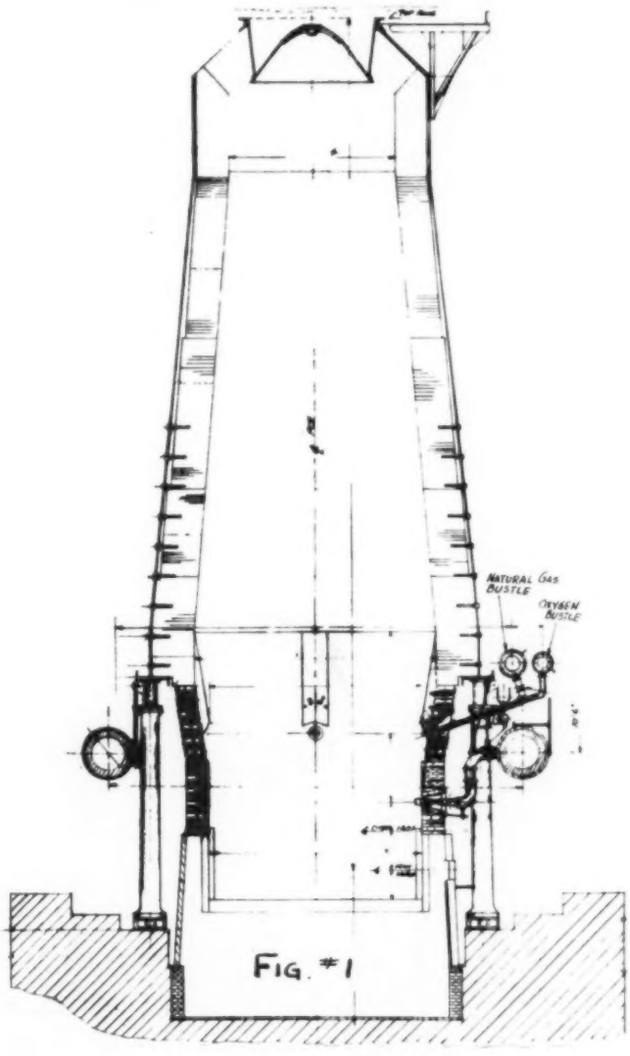
The process of reforming natural gas, oil, or any other hydrocarbon material, involves partially burning its carbon content to CO with substantially pure oxygen to produce a $CO\text{-}H_2$ mixture at high temperatures. This process takes place in a second set of tuyeres located around the furnace, preferably just below the mantle.

In any counter-current heat exchange between an initially hot stream of gases and an initially cold stream of solids, the only possible transfer of heat is from gases to solids. In order for this transfer to occur at the correct rate, the gases must be several hundred degrees hotter than the solids at the point of injection. Since this means in practice that injection temperatures of 2470 to 2900 F are usually required, it is understandable that as long as we are only partially burning to CO and not to CO_2, we can only obtain these temperatures with a rich fuel and with the use of oxygen. Even when these requirements are fulfilled, many of the most practical fuels need to be preheated before reforming. In the example of Table I in which natural gas is injected, we would use a blast furnace-gas-fired preheater which preheats both the gas and oxygen to about 700 F. With fuel oil, no preheating is required and it is even possible to inject a certain amount of steam and still obtain the necessary gasification temperatures. The volume of oxygen required for reforming natural gas is about 60 per cent of the

original natural gas volume, or about 425 tons a day maximum.

As a result of the increased amounts of reducing power and heat supplied to the shaft zone per pound of carbon burned at the tuyeres, and of the decreased heat requirements of the stack zone following the elimination of solution loss, we can expect to have to handle larger amounts of material per unit of time. As will be shown later, the increased amount of heat required in the hearth zone is most advantageously supplied by enriching the blast with oxygen. In the case shown in Table I, the oxygen requirement for enriching the blast is about 247 tons a day, making an overall oxygen requirement for reforming and oxygen-enrichment of about 672 tons a day. The amount of oxygen put into the blast can be varied considerably provided that compensating changes are made in the volume of reformed natural gas injected near the mantle. As a result of the increased heat requirements of the hearth zone, it may be stated that it would be impossible to operate the furnace with any considerable amount of natural gas or fuel oil injection without oxygen enrichment of the blast. Another reason why we need oxygen-enrichment is that if reformed natural gas or fuel is injected near the mantle, the gas volume per minute will increase. Since we have already seen that the amount of carbon burned per minute at the tuyeres will remain about the same in a furnace of given size, it is clear that gas injection will bring about excessive top gas volume and, consequently, excessive flue dust losses, unless this tendency is somehow offset. We accomplish this by enriching the blast with oxygen, thereby decreasing the volume of combustion gas per pound of carbon burned due to the elimination of nitrogen. This, together with the elimination of the CO gas from the reaction $C + CO_2 = 2\ CO$, keeps the top gas volume in balance. In illustration of this, reference is made to the three columns of figures in Tables I and II. For simplicity, each of the columns refers to a constant degree of oxygen-enrichment of the blast. Although this condition is satisfactory for the smaller amounts of natural gas or fuel oil used in the second and third columns in each of the tables, in the first column the top gas volume per minute has become excessive. This condition can be remedied by an increased degree of oxygen-enrichment of the blast, by pressure operation, or by a combination of the two.

Figure 1 — Sketch shows modifications required on a furnace which would use reformed natural gas.



The biggest cost in this installation is the oxygen plant, which will cost approximately half of the cost of the coke oven capacity replaced. Of course, such cost figures are only intended for the purpose of visualizing the possibilities, since conditions in each plant have to be studied on their own merits. In addition to the cost of the oxygen plant, our estimates indicate that, in the case of natural gas, the cost of the remaining equipment to perform this work is about $250,000 above the cost of a normal rebuild. In the case of fuel oil, the cost will be on the order of $150,000 above a normal rebuild.

An additional factor worth noting is the expected overall distribution of gas resulting from gas injection. This subject will not be discussed in detail in this space, since it is broad enough in itself to justify an entire paper. With Mesabi ores, Kinney's work showed that there was an annular region through the stack and the top of the bosh between the walls and the center where the gas volumes were low in spite of a rather high rate of travel of the solid materials, and where, consequently, insufficient reducing capacity was present to reduce the iron until it entered the bosh. Another reason for this condition may have been that in these regions insufficient coke was present to regenerate the gases at each succeeding temperature level by the solution loss reaction. About the lowest melting constituent in the charge is carbon-saturated iron, which melts at 2075 F. FeO-containing mixtures melt at a considerably higher temperature. The presence of unreduced oxides and insufficient mixing of carbon with the iron means that melting temperatures of the iron-containing constituents increase. The high-temperature heat required to melt these materials is only available from a small region around the tuyeres and over 50 per cent or more of the total heat delivered to the hearth zone is consumed in radiation and convection losses. Without pursuing the subject further, we may state that, if insufficient reduction of iron takes place in the stack, neither heat, time, or space is available to accomplish this reduction, as well as the subsequent melting, in the hearth and bosh. Consequently, a furnace operating in

this manner is out of equilibrium and the accompanying symptoms of this disequilibrium include a pasty bosh, buckshot in the slag, hanging and sticking, or other troubles.

Returning to the injection of CO and H_2 gas near the mantle, clearly these gases must have a beneficial effect, tending to loosen up the stock column and provide better gas-solid contact in the region where reduction tends to be incomplete, and where scabs and scaffolds start to develop.

Tables I and II show some results of injecting reformed natural gas and reformed fuel oil into a furnace charged with well-prepared raw materials. The consumption of natural gas may be gradually increased from zero up to approximately 6750 standard cu ft per ton, the amount shown on Table I, with about 60 per cent of this volume of oxygen for reforming. The oil consumption may likewise be gradually increased to about 50 gal per ton of iron. As the volume of reformed gas or oil is increased, a corresponding increase should take place in the degree of oxygen-enrichment of the blast. The furnace will take a heavier burden as the gas injection develops increased top temperatures. The degree of oxygen-enrichment should be governed by the top gas volume and by conditions in the hearth, including temperatures and condition of metal and slag. In many cases, even in the East, the cost of the required hydrocarbon fuel and oxygen per ton of the increased iron production can be expected to be less than the cost of the coke replaced. As already shown, the amortization cost is very low since no new blast furnace needs to be built, and the cost of the O_2 plant is only about half that of the additional coke plant that would have been required.

With reformed natural gas and fuel oil injection, there will be a considerable decrease in the quantity of sulfur charged to the furnace per ton of hot metal produced, and also in the amount of acids charged with the coke ash, so that 23 per cent less flux is required in the case shown in Table I, and the slag volume is correspondingly less. Use of a low-sulfur Bunker C oil with less than 1 per cent sulfur will also result in greatly decreased weights of flux and slag required.

In case of maximum quantity of reformed natural gas is injected into a furnace operated under normal pressures, the blast volume per ton of iron will decrease over 60 per cent, resulting in a large decrease in blowing costs, and even the blast volume per minute will decrease considerably due to oxygen-enrichment of the blast. The top gas volume per ton will decrease about 36 per cent, but the top gas volume per minute will remain about the same as in conventional practice.

Figure 2 provides W starting-point for developing the thermodynamic theory of the blast furnace. This

TABLE I

Comparison of Operating Data for a Normal Furnace and One Operating with Oxygen-Reformed Natural Gas Injection at a Second Tuyere Level and 26 Per Cent Oxygen by Volume in the Blast

	Basis—1 net ton hot metal			
	6755 cu ft Natural gas per net ton =12037 cfm	4222 cu ft Natural gas per net ton =5750 cfm	3377 cu ft Natural gas per net ton =4269 cfm	Normal operation
Charge:				
Coke, lb per net ton	916	1,143	1,218	1,890
Ore, lb per net ton	3,705	3,701	3,699	3,687
Limestone, lb per net ton	737	769	779	961
	5,358	5,613	5,696	6,538
Production of hot metal with 992 lb carbon per min burning at tuyeres, net ton per day	2,495	1,907	1,769	1,240
Slag volume, lb per net ton	862	907	919	1,120
Oxygen:				
For enriching blast, cu ft per net ton	2,332	3,053	3,290	.....
For reforming, cu ft per net ton	4,067	2,542	2,034	.....
Total, cu ft per net ton	6,399	5,595	5,324	.....
Overall oxygen requirement, net ton per day	672	448	396	.....
Air blast (5 gr H_2O), cu ft per net ton	31,126	40,726	43,870	86,663
cfm	55,465	55,465	55,465	75,050
Top gas volume (dry), cu ft per net ton	67,897	73,056	74,939	118,500
cfm	121,000	99,500	94,700	105,000
Btu available in top gas, Million Btu per net ton	8,326	7,914	7,837	10,428
Consumption at stoves, Million Btu per net ton	760	995	1,001	1,940
Consumption at O_2 and N_2 gas preheaters, Million Btu per net ton	1,095	684	547	.....
Total consumption, Million Btu per net ton	1,855	1,679	1,548	.....
Net available Btu, Million Btu per net ton	6,471	6,235	6,289	8,488
Heating value of gas, Btu per cu ft	122	108	105	88

Note: All gaseous volumes are at standard conditions.

TABLE II

Comparison of Operating Data for a Normal Furnace and One Operating with Oxygen-Reformed Fuel Oil Injection at a Second Tuyere Level and 26 Per Cent Oxygen by Volume in the Blast

	Basis—1 net ton hot metal			
	50 Gal per ton	37 Gal per ton	31 Gal per ton	Normal operation
Charge:				
Coke, lb per net ton	872	1,049	1,133	1,890
Ore, lb per net ton	3,706	3,703	3,701	3,687
Limestone, lb per net ton	731	756	768	961
	5,309	5,508	5,602	6,538
Production of hot metal with 992 lb carbon per min burning at tuyeres, net tons per day	2,625	2,097	1,914	1,240
Slag volume, lb per net ton	862	891	905	1,120
Oxygen:				
For enriching blast, cu ft per net ton	2,084	2,611	2,857	.....
For reforming, cu ft per net ton	5,394	4,043	3,371	.....
Total, cu ft per net ton	7,478	6,654	6,228	.....
Overall oxygen requirement, net ton per day	877	604	533	.....
Air blast (5 gr H_2O), cu ft per net ton	29,588	37,043	40,569	86,663
cfm	55,465	55,465	55,465	75,050
Top gas volume (dry), cu ft per net ton	66,902	72,733	75,603	118,500
cfm	125,400	109,000	103,300	105,000
Btu available in top gas, Million Btu per net ton	7,267	7,436	7,545	10,428
Consumption at stoves, Million Btu per net ton	1,118	1,091	1,070	1,940
Net available Btu, Million Btu per net ton	6,149	6,345	6,475	8,488
Heating value of gas, Btu per cu ft	114	108	105	88

Note: All gaseous volumes are at standard conditions.

diagram will illustrate several important points. In it are plotted various temperatures of the gases resulting from the combustion of one lb of carbon at the tuyeres with moist air. Temperatures lie along the abscissa and heat contents along the ordinate. The total heat q'_f available to the furnace is the difference between the value of the ordinate corresponding to the combustion temperature and the value of the ordinate corresponding to the top temperature.

The basis of this curve is the pound of carbon. Since the number of lb of carbon burned per minute is a constant determined by statistical evaluation of the rate at which furnaces of different sizes burn carbon at the tuyeres, this figure can be used as a constant in a thermodynamic calculation. Thus, values of Btus per pound of carbon, when multiplied by the constant rate of carbon combustion, give a measure of heat input to the furnace and its various zones per unit of time.

It can be intuitively understood, and particularly so when dealing with gas injection which involves two different points of application of heat, that a balance of heat input and heat requirements must exist in two separate zones, whose boundary can be defined by the temperature level of the descending materials at the point of injection. In our method of calculation, we divide the furnace into a preparation and a melting zone, the boundary of which is determined by the slag melting temperature. Since in any countercurrent process involving heat transfer from gases to solids the gas temperature at any point must exceed the solid temperature, we take the gas temperature entering the preparation zone several hundred degrees (and in this case 400 F) above the temperature of the descending materials.

In a conventional furnace, the heat delivered to the preparation zone per pound of carbon, which we will call q'_p is a function of the volume and specific heat of the combustion gas, and also, of the top temperature and the slag melting temperature. If we increase the proportion of oxygen in the blast, we decrease the volume of gas traversing the preparation zone per lb of carbon and, consequently, we decrease q'_p. Since the rate of carbon combustion is taken as a constant in our thermodynamic calculations, this means that the rate at which heat is being delivered to the preparation zone is being decreased by oxygen-enrichment of the blast or, in other words, less Btus per minute are being delivered to the materials beneath the slag melting temperature. Consequently, it takes the materials a longer time to reach the correct reaction temperature, and to undergo endothermic reactions, etc. On the other hand, the heat input to the melting zone, which we designate q'_m, is being continually increased, and of this heat, 50 per cent or more is lost in any case in the form of radiation and/or convection. Figure 2 shows clearly how large a proportion of the total heat would be delivered to the melting zone if it were possible to operate a furnace by burning pure oxygen, and it makes it possible to visualize why, even with an enrichment of only 4 or 5 per cent, there is not enough heat available beneath the slag melting temperature for carrying out the reactions in the correct order and at the correct

temperature levels, and consequently, the furnace goes out of equilibrium.

The uppermost curve in Figure 2 shows the conditions with reformed natural gas injection. It shows that there is not only enough heat available to the preparation zone per pound of carbon burned at the tuyeres, but there is, frequently, even an excess over conventional practice. Furthermore, the amount of heat available to the melting zone per pound of carbon can be increased by increasing the degree of oxygen-enrichment of the blast entering the hearth. This shows clearly that the only possible case in which oxygen-enrichment of the blast can prove economically feasible and provide substantially greater iron production is the case in which additional heat and reducing power are furnished to the preparation zone in the form of oxygen-reformed hydrocarbon gases.

In closing, we would like to say that, in order to expand production with existing methods, it would be necessary to add additional blast furnace units complete with coke plant and other facilities, whereas by our proposed method, we expect to obtain the same increase in production with existing blast furnace and coke oven facilities, so that the only new equipment required is the oxygen plant and minor equipment around the furnace itself.

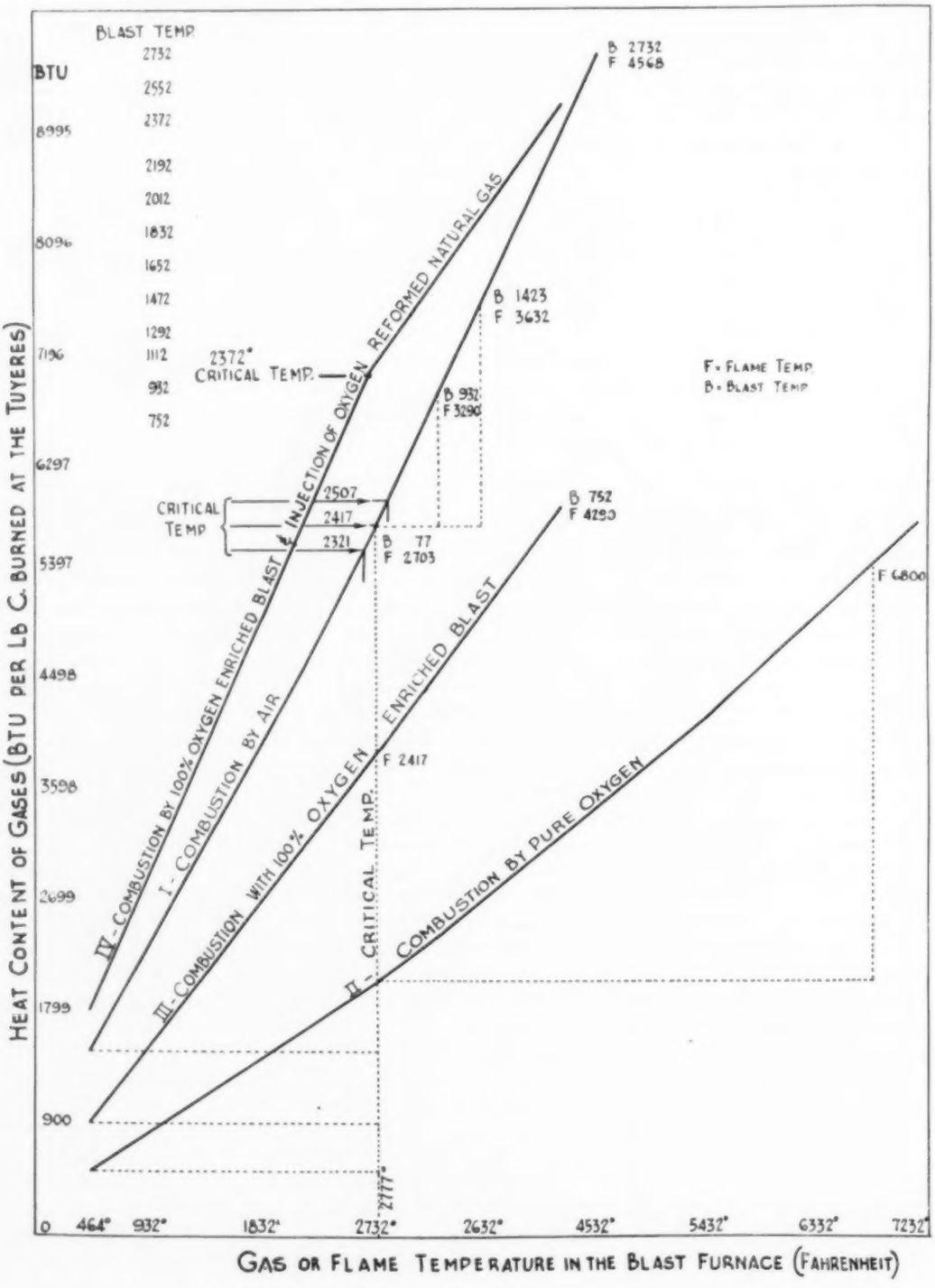


Figure 2 — Heat content of the gases resulting from the combustion of one lb of carbon at blast furnace tuyeres.

Selection and Analysis
OF REGULATING SYSTEMS FOR MILL DRIVES

By W. E. MILLER
Manager, Steel Mill Section
Industrial Engineering Department

and

F. S. ROTHE
Manager, Control Systems Section
Analytical Engineering Department
General Electric Co.
Schenectady, N. Y.

. . . . with today's analytical know-how, it is possible to select the right control system and regulating equipment, predict system performance, and quickly achieve such performance . . . .

▲ THE outstanding production records being made today in the steel industry are to a very considerable extent the results of improvements in the art of regulating system design. Much has been reported in the popular press of the computing machines, mechanical analyzers, and electronic brains that have made possible the almost uncanny accuracy of the gunfire control systems used on today's bombers and warships. While there is a world of difference in the size and weight of aircraft and steel mill equipment, the mathematics expressing the performance of the two are similar. All the modern calculating tools available are being utilized to bring forth the utmost in performance on both types of equipments.

However, more is required than just a knowledge of mathematics and differential equations. A successful application of regulating equipment involves a thorough understanding of the process involved and an appreciation of the factors affecting product quality as well as tonnage. The first and most important step in the application of regulating systems is to select the right type of equipment and system for the job.

BASIC CONCEPTS

Control systems may be of the "open loop" or "closed loop" type. The open loop system bases its control on some absolute standard. In the open loop system there is no provision for the control to know how well the system is functioning. A generator with its voltage controlled by means of a field rheostat, as shown in Figure 1, is a simple open loop system. The standard is the position of the field rheostat. The system is unaware of any other changes such as changes in load of the generator, changes in generator speed, or in shunt field resistance. When load is applied to the generator shown, the voltage drops from 250 to 225 volts. Because the system is unaware of existing conditions, it is said to have no feedback, and thus is an open loop system.

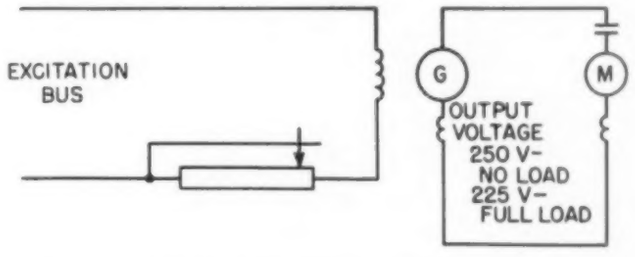


Figure 1 — Schematic diagram of open loop control system.

If the generator control system could sense the existing conditions, and then act accordingly, it would be a closed loop system. Such a control system would be composed of several components. The basic ones are an error-sensing device, the control elements and the controlled system. The error-sensing device emits an error signal to the control elements. The control elements amplify the error signal to operate the controlled system to obtain the controlled variable, or output. In a closed loop system, a portion of the output is fed back to the error-sensing device. This signal must oppose the

standard signal to obtain the error signal. When the feedback signal equals the standard signal, the error signal will be zero, and the control system will be at rest. A block diagram for a typical closed loop system is shown in Figure 2.

If a rotating regulator exciter is used to supply shunt field current to the generator, and the connections are properly made, a feedback control system may be obtained. One rotating regulator field may be used to measure the difference between the reference voltage and the output voltage. The difference, or error voltage excites the rotating regulator. Due to its very great power amplification and flexibility, the rotating regulator exciter in this case is the error-sensing device, and the control element. The generator voltage is the controlled variable in this feedback control system. Such a system is shown in Figure 3.

This closed loop generator voltage control system will still have some regulation, but it will be considerably less than that of the original open loop system. If the generator no load voltage is 250 volts as before, and if the regulating system requires 10 volts for excitation, then the reference voltage must be equal to 260 volts. This 10 volts required for system excitation is also called the error voltage because it is the difference between the desired voltage and the reference voltage. The ratio of output voltage to error voltage is 25. This ratio is known as system gain. A one volt change in error voltage will take care of a 25 volt change in output voltage.

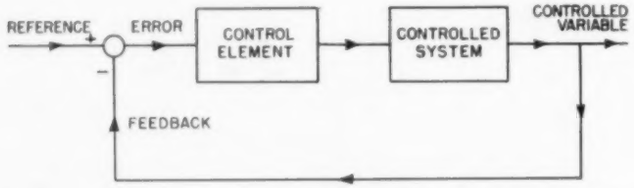


Figure 2 — Block diagram of closed loop control system.

Now, with the regulating loop or circuit established, when load is applied to the generator, the terminal voltage will drop from 250 to 249 volts instead of down to 225 volts. The one volt system regulation is all that is required to produce the additional 25 volts of generator internal voltage to compensate for generator IR drop or regulation. Of course, this is a simplified analysis of the problem and assumes that the machines are unsaturated. However, this case illustrates how a regulating system can improve steady state performance. A simple equation can be written to express the relation worked out above. It is:

$$\text{System Regulation} = \frac{\text{Open Loop Regulation}}{1 + \text{System Gain}}$$

For the example given

$$\text{System Regulation} = \frac{25 \text{ volts}}{1 + 25}$$

$$= 0.96 \text{ volts}$$

The closed loop control system will also have improved transient performance. When the reference voltage is changed, an error voltage many times normal is suddenly made available to force the change to the new operating level. As the desired voltage is approached, the forcing decreases and the error approaches the steady state value required to supply the system excitation.

TYPES OF REGULATING EQUIPMENT

While regulating systems may be hydraulic, mechanical, or electrical, there are certain features which usually narrow the choice. The universal use of electric motors on new mill drives makes natural the use of an electrical control system.

Before considering the performance of regulating systems in more detail, it is necessary to classify further these systems as to mode of operation. There are two distinct types of systems that are used in steel mills today. They are the relay system, and the continuous system. The relay type regulating system is usually applied to reasonably small power units. The continuous system may be applied to any size power unit.

The relay type of system has a dead band where the control system is inactive. A limit switch loop control system is of this type. As soon as the system moves from this dead band, a relay is actuated by a limit switch and causes the loop to return to the dead band. This type of system usually has a wide equilibrium position and is, therefore, not very useful where high accuracy is concerned. It also has the disadvantage of applying full power to correct a small error. Thus, its application is limited to reasonably small drives.

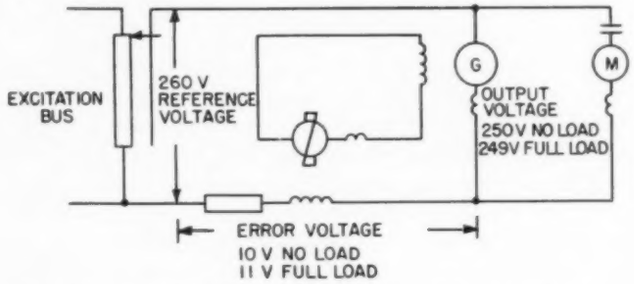


Figure 3 — Schematic diagram of closed loop control system.

The most important type of regulating system and that which is always used on main roll drives is the continuous feedback control system. This system differs from the relay system in that the correcting effort is nearly proportional to the error. This permits smoother operation and also tends to eliminate the inactive dead band. Elimination of the dead band permits greater accuracy and also improves the speed of response of the system. Rotating, amplistat, and electronic regulators are examples of continuous feedback control systems.

ROTATING REGULATORS

The modern rotating regulating system was first introduced about 1938. The success of our type of system is largely due to two characteristics of the rotating regulator exciter. First, it requires very little control power because of its high power amplification ratio. Second, its output power responds very quickly to a change in

input power. These characteristics have been obtained by an ingenious system of field and armature connections on a machine very similar in appearance to a conventional d-c generator.

This rotating regulator combines into one machine two stages of amplification, each stage of which has a very short time delay. The first stage of amplification is from the load-axis control field to the short-circuit axis. The second stage is from the short-circuit axis to the load terminals. For purposes of approximate analysis, it is as though two d-c generators were used with the first generator just as large as the second as regards voltage output capabilities.

A standard line of rotating regulator generators was developed and designed shortly after it was introduced into the steel industry. These rotating regulators have standard ratings — kw output, the product of rated voltage and rated current. Application standards were established for control fields. Thus the rotating regulators used on the blast furnace equipment can be interchanged with those used on the blooming mills, cold mills and processing equipments. The steel industry has benefited by this long range application engineering. In addition, the tremendous power amplification and fast response of the rotating regulator generator have always provided operating margin in regulating systems to insure many years of accurate and uniform operation without readjustment of the system.

MAGNETIC AMPLIFIERS

The amplistat regulating system, a relatively newcomer, is finding many applications in the steel industry. This system differs from the rotating regulator system in that the control element is a static device rather than a rotating device. This static power-control device combines a saturable-core reactor and a rectifier in a self-saturating circuit. A schematic diagram for an amplistat is shown in Figure 4.

The reactor somewhat resembles a transformer with several windings linking one or more laminated iron cores. However, it differs from the transformer in that the core is designed to be operated in the region of magnetic saturation during part of each cycle. Selenium and germanium crystal rectifiers are most commonly used with the reactors. The output current of this combination which flows through the output winding of the reactor has a d-c component and produces the bulk of the magnetizing force on the core of the reactor. The magnetizing force furnished by the d-c control winding or windings is usually only a small fraction of that furnished by the output winding, but holds the "balance of power" in saturating the core. When the core saturates, the impedance of the output winding and the a-c voltage induced in the output winding is practically eliminated; permitting a large direct current to flow to control the operation of the system.

It should be noted that the amplistat performs as a current amplifier while the rotating regulator acts as a voltage amplifier. The rotating regulator is inherently reversible while the amplistat has the irreversible characteristics of the rectifier. For reversing applications, either two generator fields and two amplistats must be used, or efficiency must be sacrificed in the two amplistat units to convert them from current amplifiers to a reversing voltage amplifier. In either case, two sets of reactors and rectifiers are required. In the first case, more copper is required on the pole pieces of the generator usually meaning a larger generator. In the second case, larger amplistat units with a continuous internal power loss are required.

Even when two fields are used on the generator, each amplistat unit may need to be larger than that required for non-reversing operation if a very fast reversal of generator voltage is required. The forward field and the amplistat rectifier circuit tend to behave as a shorted winding and will act to slow down the flux change called for by the increasing current in the reverse field. Each application of self-saturating magnetic amplifiers for reversing duty must be completely studied; first, to determine the suitability of the application; and, second, to determine the most suitable means of obtaining reversing operation for that particular application.

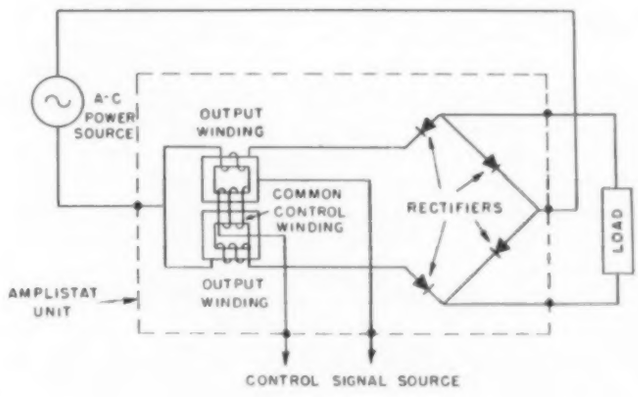
ELECTRONICS

Electronic equipment is widely used in the steel industry. However, on main drives, power electronic equipment is more generally used than is electronic control equipment. Ignitron mercury arc rectifiers have been generally accepted as the standard power conversion equipment for hot strip finishing mills. And rightly so, this equipment is reliable, quiet, does not require any expensive foundations, and it is efficient.

Electronic control elements should and have generally been used in steel mill regulating systems only when the characteristics of the application are favorable to electronic control. Rotating regulator and amplistat equipments are generally considered more reliable than electronic equipment. However, on some applications, greater accuracy and faster speed of response are required. On others, the input signal from which the drive must be controlled is at a very low power level. On very small processing drives, electronic equipment may be considerably less expensive. And sometimes, there is no other satisfactory way to solve the problem. Under these conditions, electronic control must be used entirely or in addition to rotating regulator or amplistat equipment.

One of the most promising developments in recent

Figure 4 — Diagram of amplistat using single phase bridge circuit shows core arrangement.



years in electronics is the transistor. This tiny simple device promises to someday replace the electron tube. Transistors use various kinds of germanium crystals and can be used to amplify signals, act as oscillators, relays, and as phototubes. One of the biggest advantages of the transistor is its lack of a heated filament, another, its extremely small size. The most important to the steel industry is its expected life — many years. Although at present, transistors are still in the laboratory development stage, their use in conjunction with amplistats and rotating regulators promises someday to make possible systems with present-day electronic system performance and with the ruggedness and reliability characteristic of today's amplistat and rotating regulator systems.

SYSTEM AND DRIVE CHARACTERISTICS

There are several quantities on main drive systems that can be regulated. These are voltage, speed, position, current, and tension. The selection of the proper quantity or combination of quantities to be controlled is dependent upon a thorough understanding of the process involved, and an appreciation of the factors affecting product quality as well as tonnage. The selection of a speed regulator instead of a voltage regulator, or vice versa, should not be an arbitrary one. The inherent characteristics of the regulated system selected must be compatible with the characteristics of the process. If this condition does not exist, production and quality of product will suffer. Eventually, the system will have to be changed.

It is to the benefit of the steel producer and his machinery and electric apparatus suppliers to be sure that the right system is installed. All have a responsibility in this respect; the electric manufacturer in completely understanding the process involved and in proposing the proper type of electric regulating equipment to satisfy the requirements of the process and the rolling mill machinery, and the steel producer and his machinery manufacturer in supplying the necessary information about the process and the mill equipment, and in accepting the electric control system, understanding the reasons for its selection, the system characteristics and the effect of these characteristics upon the process.

VOLTAGE REGULATING SYSTEMS

The voltage regulator is the form of feedback control system most widely used in the steel industry. It is also the simplest and easiest form of regulating system with which to work. It is used in all forms: contactor, electro-mechanical, rotating amplifier, magnetic amplifier, electronic and all types of combinations.

The selection of the type of equipment is basically one of balancing cost against performance, the size of the drive affecting the balance of the scale to a very considerable extent. On very small equipments, it is probable that only the cost of a contactor, an electromechanical, or a simple electronic regulator can be justified. On large processing or main drive equipments, rotating amplifiers, magnetic amplifiers, or these in combination with electronics are generally used.

A simple rotating regulator type voltage regulator has already been described. If this generator is used to supply d-c power to a motor, the regulator will act to maintain constant generator terminal voltage as the load on the motor is changed. However, the motor speed will still change with load as a result of regulation of the motor itself. There are two factors contributing to this motor speed regulation. The first is IR drop which causes the motor speed to drop as the load is increased. The second is demagnetization due to the load current which causes the motor speed to rise with load. Some motors, such as those used on tandem cold strip mills, are designed so that the speed regulation is equal to the IR drop and thus are internally compensated for the demagnetizing effect of the load current.

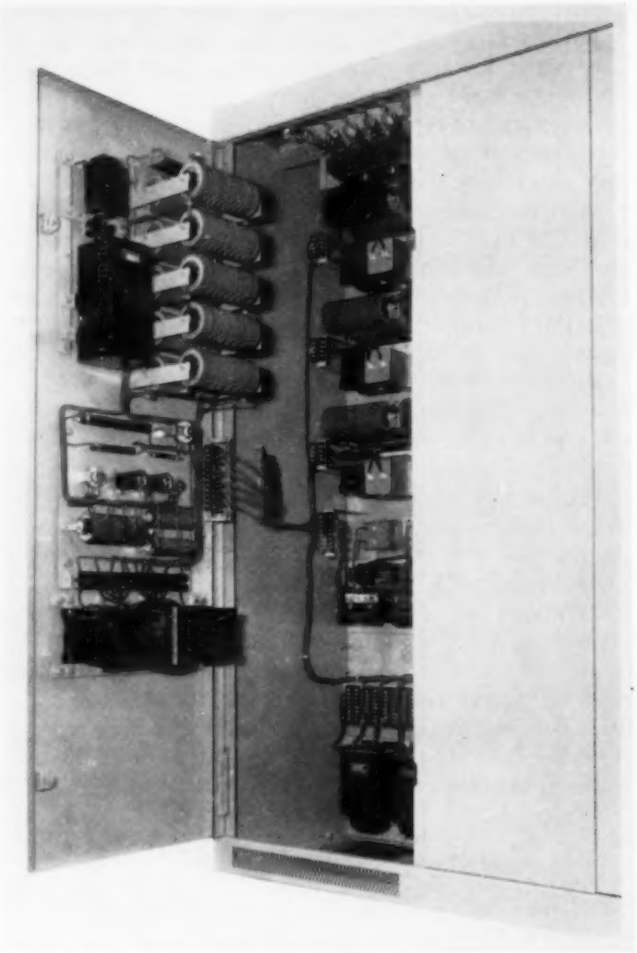


Figure 5 — Amplistat voltage regulator for ignitron rectifier is mounted on door of excitation compartment.

If another function is added to the voltage regulator to measure the load current and to add to the reference voltage, a voltage equal to all, or some portion, of the IR drop, the motor speed regulation can also be controlled. On tandem cold strip mills, IR drop voltage regulators are used. Most modern tandem cold mills use individual generator control systems and this additional function is easy to obtain and very necessary for the successful operation of the mill.

A rotating regulating system for one stand of an individual generator tandem cold strip mill is shown in Figure 6. The system shown provides voltage regulation with adjustable, regulated IR drop compensation. The system is simple in circuit and adjustment. The amount

of IR compensation can be adjusted by the mill operator to exert the amount of electric corrective effect upon the strip consistent with the product being rolled, and the conditions under which it is being rolled. When the strip is brittle or has bad edge conditions, lower values of IR compensation can be used to give a stable, accurate yet somewhat soft system.

Thus far not much has been said about time constants. However, they are the very important factors that can cause the success or failure of a regulating system. In general, the more time constants and the more nearly equal they are, the more difficult the stabilizing problem, and hence the less likely the system is to be a success without a very complete analysis in the design stage.

The simple voltage regulating system first discussed had three time constants or delays. These are in the rotating regulator main control field, the rotating regulator quadrature axis, and the generator field. With the IR compensation adjustment set to zero, the tandem mill regulating system under discussion contains the same three time constants.

The motor-mill roll combination also has a time constant. This is an inertia time constant that varies as the square of the speed range by field weakening. Approximately 80 per cent of this time delay is the result of mill inertia. With the IR compensation set at zero this time delay is effectively outside of the regulating system feedback loop. For all practical purposes, the system is the simple voltage regulator.

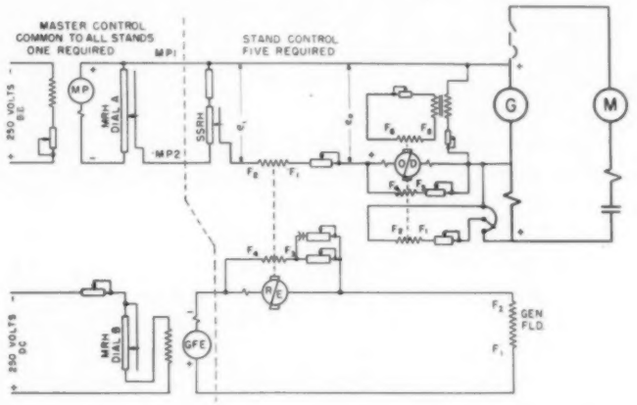


Figure 6 — Rotating regulator voltage regulating control circuit shows ohmic drop compensation for one stand of a 5-stand tandem tin plate mill which uses individual generators for each stand.

However, the presence of the motor-mill, or mechanical time constant, means that there will be a time lag between the generator voltage and the mill speed. IR compensation can be used to reduce the magnitude of this time delay. On a mill stand operating at 7000 fpm, this time constant is about 0.5 sec. A 75 per cent IR compensation would effectively reduce it to about 0.13 sec and introduce a time delay of approximately 0.37 sec inside the regulating system loop. The voltage control becomes less than critically damped, but this mode of operation is required to force the speed from an overdamped to a critically damped condition. It would be undesirable to permit the speed to become less than critically damped. Oscillations when stopping would

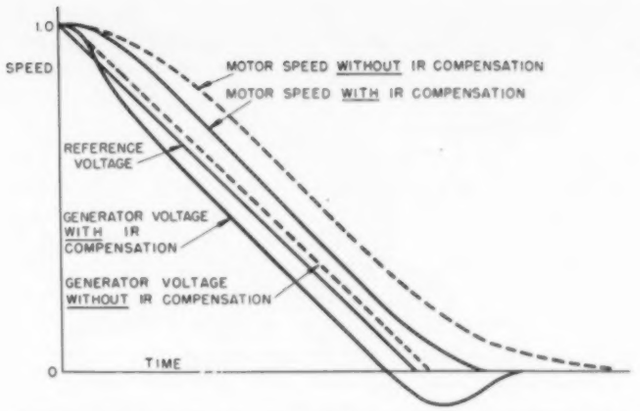


Figure 7 — Analogue computer study of tandem cold mill stand regulator shows effect of IR compensation on motor speed and generator voltage.

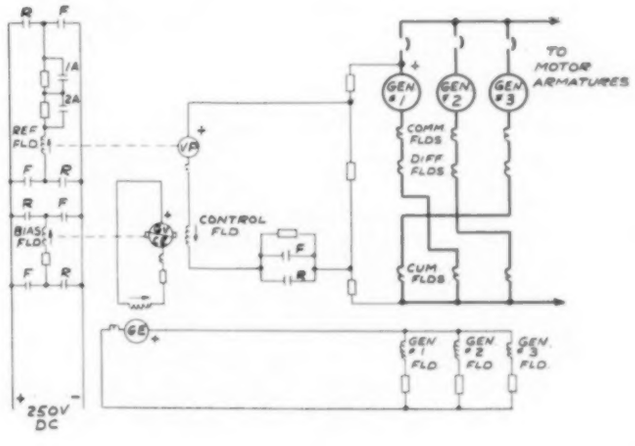
result in double or triple reduction, and the strip would "bite off" when the mill is restarted. Oscillations at running speeds would undoubtedly result in breakage, because there is little "stretch" in cold rolled strip.

The effect of changes in IR compensation are shown in Figure 7. These curves were obtained from electronic analogue computer studies of the tandem cold reduction mill regulating system.

A voltage regulating control system is also used on the reversing blooming and slabbing mill. The precise control and critical damping of the tandem cold strip mill is not required. Here the object is rapid reversal. A simplified schematic diagram of the voltage control system is shown in Figure 8. Rapid reversals are obtained by "brute force." The rotating regulator is forced to build up in a very small fraction of a second and applies many times net excitation to the generator exciter. Since the generator exciter builds up to a voltage many times the steady state excitation drop of the main generator fields, considerable excess voltage is available for overcoming the inductive drop in the field of the generator. These voltages are shown in Figure 9 and were obtained from test oscillograms. The regulating system was adjusted to give damped oscillations to better illustrate the various time lags in the system. These time lags can be seen by comparing peak voltages.

Voltage regulating control systems are also used on

Figure 8 — Generator voltage control system for reversing blooming and slabbing mill.



many other types of main drives. Systems used on reversing cold strip mills and temper mills are simple single rotating regulators. The system used on reversing hot strip mills is very similar to that used on the reversing blooming and slabbing mill.

Tandem hot mill equipments require separate consideration. These mills are non-reversing and operate at fixed speeds. The metal is put through the mill stands in separate bars following each other in succession separated by intervals when no metal is in the rolls. Thus, the motor loads change frequently and abruptly from friction load to rolling load. The d-c mill motors may be supplied with power from one bus, or a number of bus sections. Both ignitron mercury arc rectifiers and motor-generator sets are used, although rectifiers are being used on most new installations.

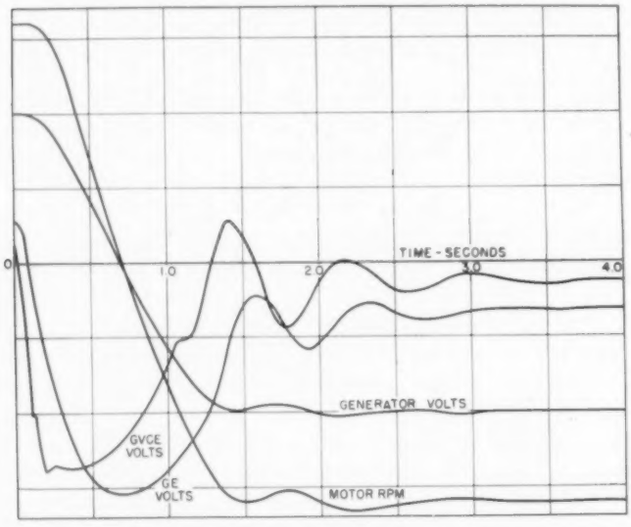


Figure 9 — Oscillograph tests of reversing blooming mill voltage control system — 6000-hp, 40-rpm twin drive — base speed reversal.

Voltage regulators are required to maintain constant bus voltage. If the bus is split into several sections, a voltage regulator is required for each bus section. Amplistat voltage regulators are used to hold constant voltage on the ignitron mercury arc rectifier systems. The amplistat is ideally suited to the characteristics of the ignitron rectifier. Both are non-reversing, and both have time constants shorter than the required system time constant. This type of system can be stabilized with a rate feedback from the output voltage. Only a few capacitors are required. Thus, the amplistat ignitron mercury arc rectifier voltage regulating system gives the required performance with a minimum of auxiliary components.

In addition to the bus voltage control systems, individual motor speed control is required on some types of tandem hot mills. As the front end of the metal hits each stand, there is an impact speed drop due to the sudden load application which is applied to each stand in succession as the front of the metal travels through the mill. This tends to upset the proper speed relationship between stands and may cause excessive looping or stretching of the metal between stands. The individual motor speed control requirements are dependent upon the product and the mill layout. No special individual motor speed control equipment has been found necessary for the rolling of hot strip. Beyond that there is general agreement that rod, bar, and merchant mills require some degree of speed matching, and that tube forming mills require the ultimate in speed control systems.

The speed matching systems used on these mills have varied from exciters connected across motor auxiliary shunt fields and excited from motor load current to complete electronic rotating regulator speed regulators controlling the motor field excitation. Armature circuit boosters with rotating regulator type IR drop or loop regulators have also been used.

Actually rod, bar, and merchant mills vary greatly in layout, and consideration must be given to the layout as well as the product in determining the requirements of the electric system. Mills operated with loops between stands generally require the least in speed compensation or regulating equipment. On closely coupled stands and on some products such as angles or other light sections, looping cannot be tolerated, particularly in the finishing end of the mill. In such cases, low impact speed drop (high inertia, low resistance, low inductance) motors and more accurate speed compensating or regulating equipment is required.

SPEED REGULATING SYSTEMS

As can be seen, it is sometimes a little difficult to draw a definite line of demarcation between those rolling processes requiring speed regulating equipment and those for which voltage regulators with IR drop compensation are entirely satisfactory. Actually, the successful applications of speed regulators to main roll drives have been pretty well limited to rod, bar, merchant, and tube mills.

Speed regulating systems tend to be a little more complicated than voltage regulating systems. First, the stability problem is more difficult because the motor

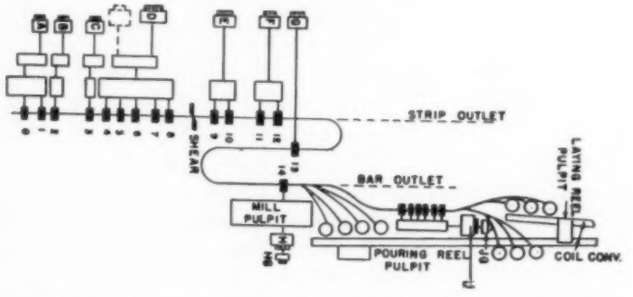


Figure 10 — Layout for combined rod and merchant mill.

inertia time constant is included in the regulating loop along with those of a straight voltage control system. Second, the speed regulating systems as used on rod and tube mills have been designed for small steady state error and fast transient response. To obtain the required performance, it has been necessary to use combination electronic-rotating regulator equipment. With electronic input, it is extremely important that the tachometer generator feedback signal be steady and free of ripple. These disturbances may very easily drive the regulating system out of its operating range. Again, regulating system performance is dependent upon the characteristics of all the components in the system. A

speed regulating system has more components, and each must be designed with overall system performance in mind at all times.

POSITION REGULATING SYSTEMS

To date, position regulating systems have been most commonly used to maintain loops and side register on processing lines. The preset screwdown control sometimes used on reversing roughing and plate mills is another example of this type of system. Position ties

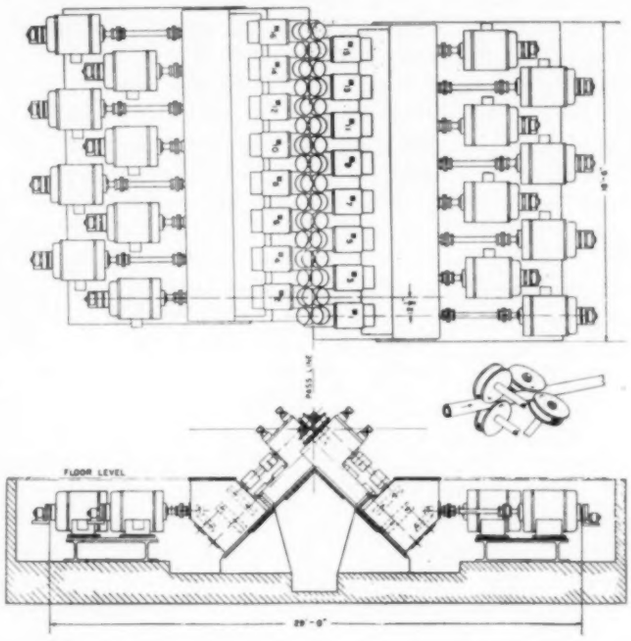


Figure 11 — Arrangement of 16-stand tube reducing mill. Each stand is driven by 75-hp, 850/1750-rpm motor.

or regulating systems have also been used on a few high accuracy strip shearing equipments. For roll drives, position regulating systems have been considered for tandem die rolling applications where the stands are driven by separate motors.

Position is the time integration of speed. That is, the positioning drive motor is required to run for some definite period of time to change the position of the geared output shaft. The electric signal proportional to position is most usually obtained from a selsyn generator, photo-electric equipment, or a magnetic proximity pick-up. This feedback signal is compared with a reference signal proportional to the desired position, and the difference, or error, is fed into the control element of the position regulating system.

Positioning systems usually include some electronic equipment. Such equipment is required with low output level photo-electric position measuring devices, and when good accuracy and speed of response are required. Positioning systems are inherently unstable for most applications and require a stabilizing feedback signal proportional to the rate of change of position. A tachometer generator gives such a signal and is commonly used. This type of stabilizing circuit has the effect of reducing the overall system gain. Thus, to obtain accuracy and speed of response, the system gain is restored through the use of the electronic amplifier. The use of the electronic amplifier also makes it easier to stabilize the position regulating system. Many times the rate feedback signal can be obtained electronically without the use of a tachometer.

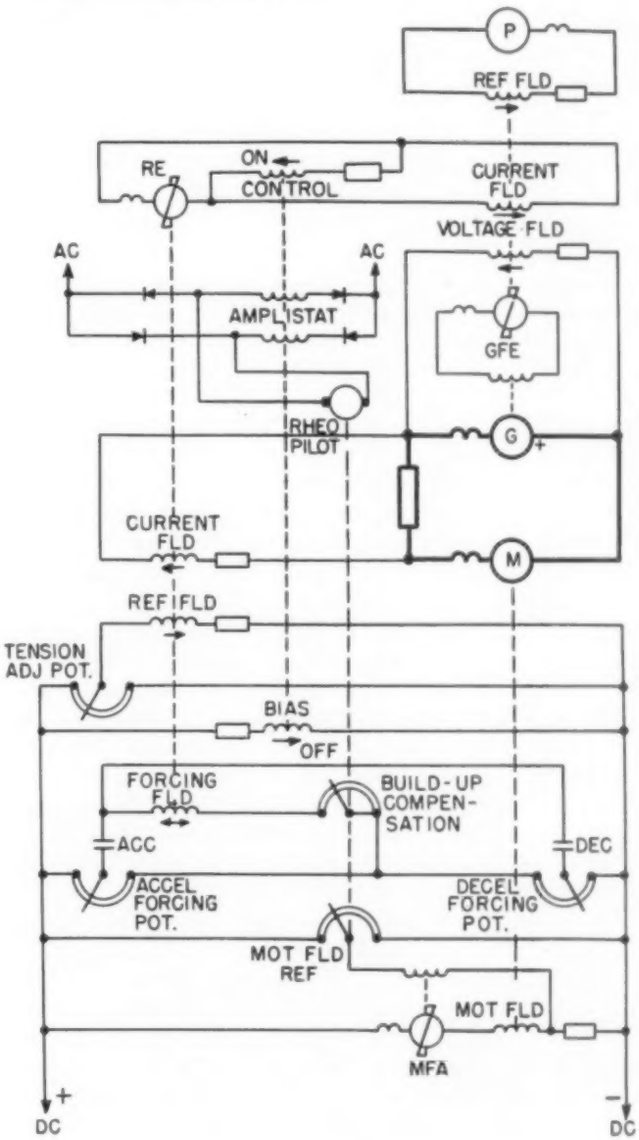
Positioning systems require more components, are more complex, and find less use on main roll drives than any of the previously mentioned types of systems.

CURRENT AND TENSION REGULATING SYSTEMS

Almost every continuous strip process in the steel industry requires automatic tension control. In a few cases, strip tension is regulated by actually using a tensiometer to measure the tension in the strip and comparing the electric signal proportional to tension with an electric signal proportional to the desired tension. This type of system is used to control strip tension between stands on two-stand temper mills. However, in practically all other cases, current regulators are used to obtain automatic control of strip tension.

The control circuit for the tension reel on a cold strip

Figure 12 — Simplified schematic diagram of current regulator for tension reel.



mill is shown in its simplified form (less stabilizing elements) in Figure 12. The system is arranged so that the reel generator voltage is proportional to strip speed. The pilot generator driven by the mill motor provides the basic reference signal for the tension reel voltage regulating system (amplidyne GFE).

Reel build-up and automatic tension control are taken care of by current regulating rotating regulator RE. This rotating regulator acts to maintain constant reel motor armature current by changing the excitation on the second reference field on rotating regulator GFE, and thus changing the generator voltage. As the coil builds up on the winding reel, the line current will tend to increase because the reel is trying to run too fast. The current regulator will then cause the generator voltage to decrease so as to hold constant current.

An amplistat winding is also connected across rotating regulator RE. The voltage of this regulator reverses to reduce the generator voltage. This reverse RE voltage turns the amplistat on. The amplistat supplies power to the rheostat driving motor which increases the shunt field excitation on the reel motor causing it to tend to slow down and thus reducing the armature current. The current regulator through RE then restores the generator voltage to normal.

The transient response of the rotating regulator portion of the system is very fast. The sensitivity of the amplistat portion is very high. Combined together as shown, the amplistat and rotating regulator give an excellent current, or tension control system. As the coil builds up, the regulating control system automatically increases the shunt field excitation to reduce the angular speed of the reel motor and to increase the motor torque in proportion to the build-up to maintain constant tension in the strip. The motor field current regulating rotating regulator MFA is used to obtain precise control of the reel motor field.

Since the amplistat is non-reversing, the motor driven rheostat position will remain fixed when the drive is stopped and restarted. The regulating system thus "remembers" the coil diameter. An auxiliary dial may be used to recalibrate the "forcing" or inertia compensation required during acceleration and deceleration as a function of coil build-up. The rheostat is returned to its initial position when the mandrel is stripped.

Current regulators are preferred over tensiometer type regulators for control of strip tension on unwinding and winding reels, and on tension rolls. The coils generally are not perfectly round, and the variation in diameter introduces forced oscillations into the regulating system. The oscillations are less severe when a current regulator is used. The tensiometer form of regulator is used for automatic control of tension between stands of two-stand temper mills because stand motor load currents are not indicative of strip tension alone. The tensiometer is required to obtain the feedback signal for the regulating system.

Tension control systems utilizing current regulators are seen to be more complex than voltage regulating systems. The one for the cold strip mill tension reel consisted of a voltage system plus a motor field excitation system. However, all the systems discussed can be analyzed, and design methods and tools are available to select the circuits and circuit constants which will give the desired system performance.

ANALYSIS OF SYSTEMS

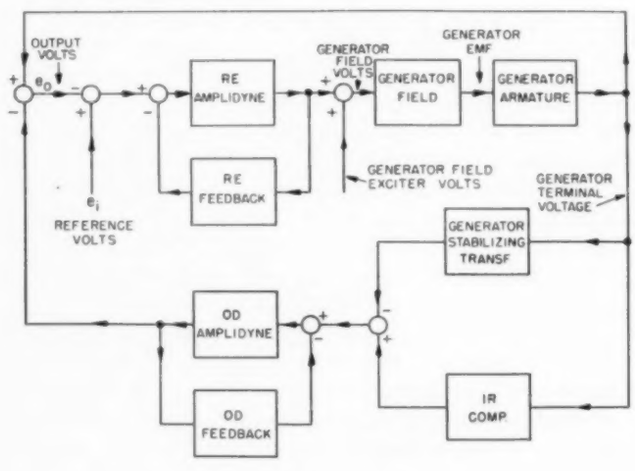
There are a number of factors which must be included in an analysis of a regulating system for steel mill drives. After the ratings of the main drive motors and generators have been selected and a decision made as to the type of other components to be used, the ratings of these components must be determined. In many cases, these ratings are based only on the steady state performance of the equipment since rapid changes in speed or torque are not required of the drive. Frequently, however, the transient specifications of the system must be considered. For example, the time required to stop a tandem cold strip mill running at top speed might be specified. Similarly, in a reversing blooming mill, the time required to reverse from base speed in one direction to base speed in the other direction will be an important factor in determining the ratings of the generator exciter and its associated controls.

The reason why the transient requirements are important is the ever present element of inductance in the field circuits of the main generators and motors. The ratio of the field inductance to its resistance, which is the time required for the field current to build up to 63 per cent of its final value when voltage is suddenly applied, is in the neighborhood of 3 sec for most large d-c generators used in steel mill drives. Obviously, then in those cases where fast response of the terminal voltage is required a much larger voltage must be made available from the exciter than is necessary for steady state requirements. Since the exciter itself has a time delay of varying magnitude depending on whether it is rotating regulator, amplistat, electronic, or straight d-c generator, this concept of a forcing voltage must extend all the way back through the chain of the regulating system to the initial control signal itself.

One very useful method of understanding the action of the regulating system is the use of a block diagram. Such a diagram for the stand voltage regulator of Figure 6 is shown in Figure 13.

Essentially the block diagram tells how the system works. The arrows and junctions show the flow of information in the regulator. Notice the diagram is not an equivalent circuit nor does it indicate the power level of the various components. In this case, since the con-

Figure 13 — Block diagram of stand voltage regulator for tandem cold strip mill.



trolled quantity is the generator voltage, the variables shown in the circuit are voltages.

Each of the blocks shown represent what is known as a transfer function. The function in the generator block describes, for example, the manner in which the exciter voltage produces a generator output voltage. In general, it may not be simple to express this relation mathematically unless simplifying assumptions are made. In the example chosen, there may be such complicated effects as hysteresis, saturation, and eddy currents to consider if the exciter voltage is changed suddenly. The decision as to the relative importance of these effects is based on engineering judgment so that a control system analysis requires considerable experience and checks against the actual field operating data on similar systems.

Another complication is that the transfer function usually varies with time. If a sudden change is made in the exciter voltage, for example, the generator terminal voltage instead of changing instantly, builds up exponentially if eddy current effects are neglected.

The theory of operational calculus makes it possible to represent this type of response by a simple algebraic equation. Thus

$$\frac{V_{generator}}{V_{exciter}} = \frac{K_{fd}}{1 + pT_{fd}}$$

K_{fd} is the gain in the system, T_{fd} is the time constant or the ratio of field inductance to field resistance, and p is the operator used in place of the time derivative. The manner in which the generator output voltage varies with time may be found at the two extreme values of time as follows: At the instant of application of the exciter voltage when $t=O$, let $p=\infty$ in the transfer function. Then evidently the initial change in generator voltage is zero. To find the value of the generator voltage in the steady state when $t=\infty$, let $p=O$ in the transfer function. Then the change in generator voltage is K_{fd} times the change in exciter voltage in the steady state.

By analyzing the transient behavior of each of the blocks in the diagram, a complete mathematical description of the system can be obtained in terms of gains, time lags, and the operator p.

With the block diagram approach to control problems, certain features of the diagram appear which are common to a large variety of regulating systems. The theory of servomechanisms which grew so rapidly during the last war because of the extensive use of gun directors and radar systems is directly applicable to the general class of feedback control systems which include such widely different functions as temperature control, pressure regulators, and speed governing systems, in addition to the voltage and current regulating systems with which the industry control engineer is most familiar. As an example of this general approach, consider a control system to be made up from two general transfer functions as shown in Figure 14.

The function G(p) is the overall transfer function which describes the response of the controlled variable to the error signal e. The function H(p) is the function which describes the amount of the controlled variable which is fed back to be compared with the desired reference r. In the stand voltage regulator without IR Compensation H(p) is simply unity. From this simple

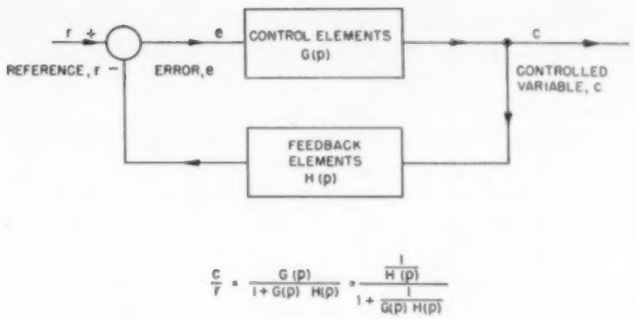


Figure 14 — Block diagram of generalized control system.

block diagram, the following fundamental relation can be obtained for the ratio of the controlled variable, c, to the desired value, r.

$$\frac{c}{r} = \frac{G(p)}{1 + G(p)\ H(p)} = \frac{\frac{1}{H(p)}}{1 + \frac{1}{G(p)\ H(p)}}$$

If this expression is examined at time zero ($p=\infty$) and in the steady state ($p=O$), it will be found that the magnitude of the general transfer functions G(p) and H(p) will, because of inductance and inertia, always approach zero as p approaches infinity. Then the product G(p) H(p) will be less than unity and the ratio $\frac{c}{r}$ will approach the value of forward transfer function G(p). Thus the instantaneous response of a control system with feedback is dependent only on the characteristics of the main control elements. However, as the variable c approaches its steady state value, the magnitude of the quantity G(p) H(p) may become large compared with unity, and as shown previously, this results in improved steady state regulation of the system.

Thus it is seen that in considering the overall transient response of c to a change in r, the characteristics of both the main control elements and the feedback elements must be considered.

The calculation of the response, $\frac{c}{r}$, for a typical system may be done directly by operational calculus, once the transfer functions G(p) and H(p) are known. Such a response of c to a sudden change in r might take several forms as shown in Figure 15. If the response were as shown in Figure 15a, the system is said to be critically damped; if the response were as shown in Figure 15c where the controlled variable does not return to a normal steady value but continues to oscillate, the system is said to be unstable.

The direct operational solution for the response is seldom practical because of the complicated nature of the functions G(p) and H(p). The expression for $\frac{c}{r}$ reduces to an algebraic equation in p which frequently is of fifth or higher order. The determination of the roots of this equation is very laborious and the effect of adjusting the elements of the system such as rotating

regulator gains and time constants is very difficult to evaluate. There are two general methods of attack, however, which can be readily applied and which yield results suitable for design purposes.

1. The transient response has been previously evaluated at zero time and at the steady state when time equals infinity. A more extensive application of this principle would be to find the response to sinusoidal variations in the reference voltage for various frequencies from zero to infinity. Both theory and common sense indicate that a knowledge of this response at all frequencies would enable one to estimate the response to any specified variation of the reference such as a sudden change or a change at a given rate. Also exact methods have been developed so that instability as in Figure 15c can be predicted from the frequency response curve and stabilizing circuits designed to insure against

it. The magnitude and phase of the ratio $\frac{c}{r}$ can be found

for sinusoidal inputs by simply replacing the operator p by the complex number $j\omega$ where ω is the assumed frequency of the sinusoidal variation in radians per second.

Thus the calculation of the ratio $\frac{c}{r}$ is simply a matter of

handling complex numbers as in a-c power circuits and a number of graphical methods are available to make the solution relatively easy to obtain. Where a large number of frequency response curves must be calculated

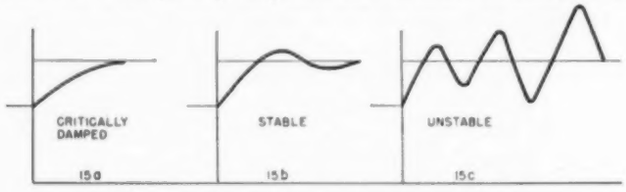


Figure 15 — Typical system transient responses.

for variations in the constants at any one element of the system such as a particular rotating regulator, a digital computer such as the IBM punched card machine can be used. Figure 16 shows a frequency response curve for a typical stand voltage regulator control. The location of the peak on this curve indicates the frequency at which oscillations might occur following a sudden change in the reference and the magnitude of the peak indicates how well damped these oscillations will be. If there is a very small peak in the frequency response curve, there will be good damping during transient disturbances.

2. The second method of calculation of performance of feedback control system is to use an analogue computer or differential analyzer to actually plot the solution for any type of transient change in the reference r. The advantages of this method are that it gives a picture of the transient performance of all components under actual operating conditions such as an acceleration to top speed or a reversal.

Analogue computers used for control system studies are of two basic types, electronic and mechanical. In the electronic computer such transfer functions as

$\frac{K}{1 + pT}, \frac{Kp}{1 + pT}, \frac{1 + pT_1}{1 + pT_2}$ may be obtained by com-

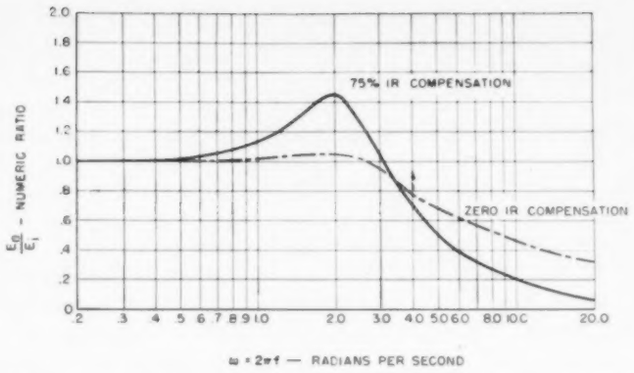
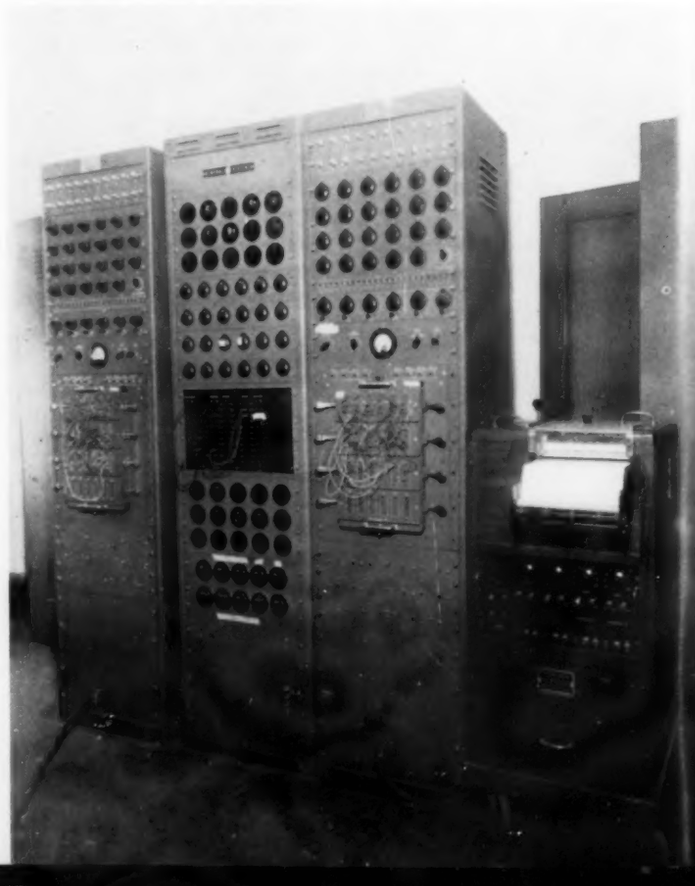


Figure 16 — Calculated frequency response of voltage regulator with IR compensation for Stand No. 5 of tandem tin plate mill. (Motor operating with weak field.)

binations of high gain d-c amplifiers with the proper electric circuit elements. The variables of the problem are represented by voltages in the computer. It is interesting to note that the same techniques of feedback used in the control system are also used in the analogue. For example, variations in the gain of the d-c amplifiers can be nullified by feedback through precision resistors and the use of high gain in the forward function G. The electronic analogue computer may be set up quickly to represent a given control system and the constants varied simply by adjusting calibrated potentiometer dials. The response of the variables can be plotted as a function of time so that an accurate record of the performance can be had and the optimum adjustments determined long before actual shipment. Figure 17 shows a modern electronic analogue computer.

The mechanical type of differential analyzer was developed by Dr. Bush at Massachusetts Institute of Technology in 1931. Many improvements have been

Figure 17 — Modern electronic analogue computer quickly solves difficult problems.



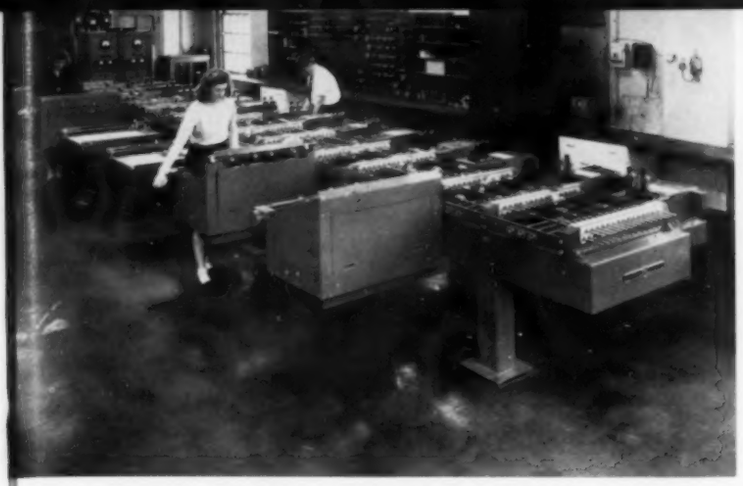


Figure 18 — Mechanical differential analyzer was developed by Dr. Bush of MIT. It can be used on nonlinear problems.

made since then so that the analyzer has great flexibility in its operation. The variables here are represented by rotation of shafts so that addition can be done by a differential gear, multiplication by a gear train, and integration by a wheel and disc device due originally to Lord Kelvin. Since integration can be done with respect to any variable and is not limited to time as with electronic computers, the mechanical differential analyzer can be used on nonlinear problems.

Nonlinear equations result when two variables must be multiplied, when it is necessary to obtain such functions as the sine, cosine, square root or logarithm of a variable, or when two variables are related by some function such as a saturation curve. The tension reel control on cold strip mills is a good example of this type of problem since here both motor field strength and motor voltage are controlled to give constant motor horsepower corresponding to constant strip speed and tension. Figure 18 shows a mechanical differential analyzer and Figure 19 results of a study of the stand voltage regulator during a stop from top speed.

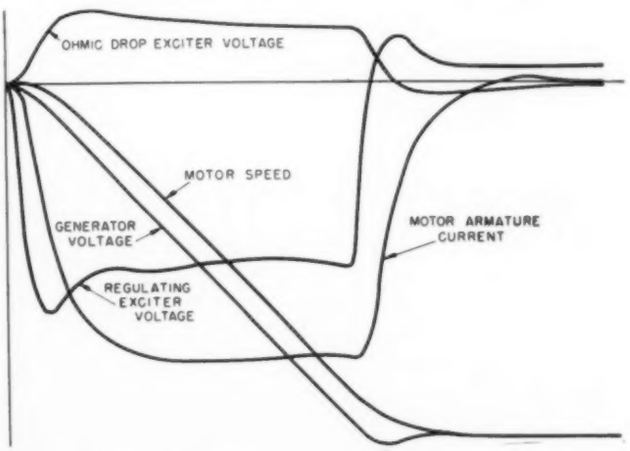


Figure 19 — Differential analyzer transient response curves for tandem cold strip mill voltage regulator.

Using these computers to supplement the simpler steady state frequency analysis, and with constant tests of actual field performance, the analysis of regulating systems for industry control has resulted in improved system design and performance and reduced installation time.

SUMMARY

Improved product quality, increased output, and reduced unit product cost are the basic aims of the steel producer as well as of every manufacturer. The electric regulating system used on today's mill drives makes it possible to achieve these aims. The feedback control system improves quality because it holds the process within very close limits by continuously checking performance against a reference, or standard, and automatically correcting for any deviation from the desired condition. Output can be increased by raising the rolling speed because the regulating system is continuously monitoring performance and quickly perceives and corrects for undesired variations in output even at very high rolling speeds. Unit product cost is reduced because the regulating system automatically and continuously makes the required adjustments without shutting down or requiring the attention of many operators to correct for the changing conditions.

The modern rolling mill is an immense installation. The mill itself is supplied by one manufacturer, the electric equipment by another. Each has several points of manufacture. These equipments are not assembled together until they reach the installation. Many millions of dollars are usually involved. The equipment must fit together easily and it must not be necessary to perform many months of testing in order to obtain satisfactory performance.

With today's analytical know-how, today's regulating equipment, and most important today's experience, it should be possible to select the proper type of feedback control system, the proper type of regulating equipment, and to predict system performance. The equipment should go into service quickly and perform as predicted.

BIBLIOGRAPHY

1. "*Servomechanisms and Regulating System Design*," by HAROLD CHESTNUT and ROBERT W. MAYER, John Wiley & Sons, 1951.

2. "*Electrical Equipment for Merchant, Bar and Rod Mills*," by W. B. SNYDER, Blast Furnace and Steel Plant, April 1950.

3. "*Electric Equipment for Rolling Cold Strip at 70 Miles per Hour*," by W. E. MILLER, Proceedings Association of Iron and Steel Engineers, 1950.

4. "*A Self-Saturating Static Magnetic Amplifier for Regulating Circuits*," by H. E. LARSON and T. DUNNEGAN, JR., Proceedings Association of Iron and Steel Engineers, 1950.

5. "*Modern Electrical Equipment for the Reversing Blooming and Slabbing Mill*," by W. E. MILLER, Blast Furnace and Steel Plant, February and March 1950.

DISCUSSION

PRESENTED BY

W. R. HARRIS, Manager, Metal Working Section, Westinghouse Electric Corp., East Pittsburgh, Pa.

T. B. MONTGOMERY, Engineer-in-Charge, Control Design, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

W. E. MILLER, Manager, Steel Mill Section, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

F. S. ROTHE, Manager, Control Systems Section, Analytical Engineering Dept., General Electric Co., Schenectady, N. Y.

W. R. Harris: The authors are to be commended for presentation of a paper which puts in good form

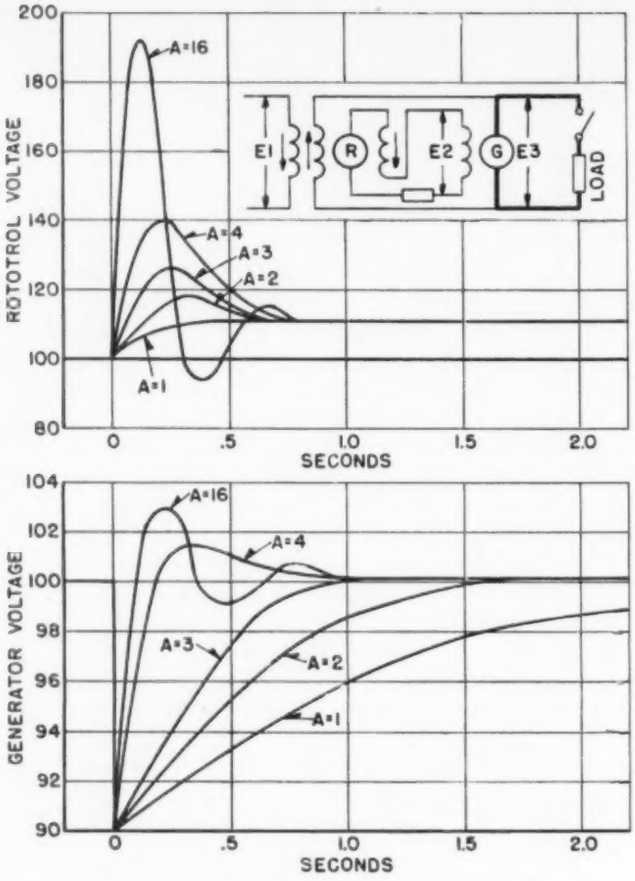


Figure 20 — Response of two delay regulating system shows effects of gain on speed of response and rotating regulator voltage.

the problems of control and regulating systems that we are all faced with today. It is pleasing to note that the authors have used voltage gain in place of power gain in discussing the regulating systems. A 25:1 voltage gain does not have as much appeal as a 25,000,000:1 power amplification but it is in general a more useful term in describing regulating systems.

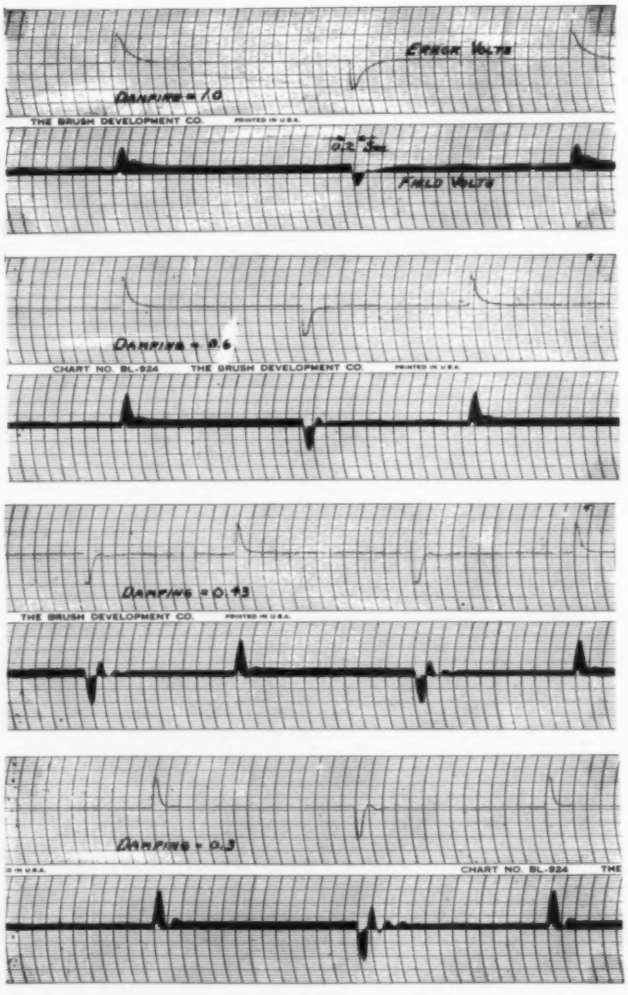
Figure 20 indicates some of the problems involved in stabilizing regulating systems which was not covered to any great extent by the paper. This shows a simple rotating regulating system in control of the voltage of a direct current generator. For this example, the rotating regulator time constant was assumed at 0.1 sec and the generator time constant at 1 sec. On the lower curve showing generator voltage, the system was deadbeat with low values of gain. With a voltage gain of four, the system was still stable but had some overshoot. With a gain of sixteen, the system was oscillatory but fairly well damped. These curves were calculated without any means of damping. With gains of sixteen and above, up to about 100 which is sometimes used, damping means must be provided in order to get a response which is free from serious overshoot or oscillation. The proper ceiling voltage must also be furnished in the regulating equipment as shown by the upper set of curves on Figure 20. This shows how the peak rotating regulator voltage increases as the gain is increased and illustrates the importance of building regulating and exciting equipment with the proper voltage margin.

Figure 21 illustrates the effect of different values of damping on regulating systems. These are response curves showing error voltage and generator field voltages for high gain magnetic amplifier voltage regulator in control of a 500-kw d-c generator. In the upper curve the response is overdamped as is the second curve. The third curve is about critically damped and on the fourth curve (damping of 0.3) there is a slight oscillation. When all damping was removed from this application the swings were too violent to record. The curve of generator field voltage also illustrates that the peak voltage applied to the field is higher as the damping is lowered. The performance of this system is very fast — approximately 0.2 sec for the critically damped condition.

If all regulating systems could be built with a single time delay there would be no stability problems because such a system cannot overshoot or oscillate. However, all practical systems have more than a single time delay so stability problems are always present. In order to minimize these problems it is desirable to build the regulating element with as small time delay as possible compared to the main drive machines.

Tests were also made on the response of a magnetic amplifier tandem mill control using 400-cycle magnetic amplifiers designed with so short a time constant that a single time delay system was approached. This test

Figure 21 — Response tests on a two-stage magnetic amplifier voltage regulator shows the effect of different degrees of damping.



was made with a 3600-kw generator with a field time delay of about 4 sec and the response is exceptionally fast and exceptionally well damped. The system is so fast that variation of the motor-mill mechanical time constant over a 4:1 range by full motor field and weak motor field charts has practically no effect on the response.

Tests were also made on the motor speed and voltage on the world's fastest reversing mill, a 10,000-hp, 40/100-rpm, twin-drive installed in the Pittsburgh district. The reversal is made in approximately 1 sec using a conventional rotating regulator control system. This is an application where we have been faced with meeting increasingly stiff requirements in reversal time. We have found that in practically all cases, after a little experience with fast reversals, the reversal time was increased in order to reduce mill maintenance. The faster the reversal the more wear on the slippers, unless the spindles are very carefully adjusted. This leads us to the conclusion that one second is generally a lot faster than is required. Expression of opinion from operating people on this point would be very welcome.

The remarks of the authors on the assumptions necessary to simplify systems for ease in handling on computers are well taken. Modern computers are wonderful machines and have simplified the performance analysis of regulating systems tremendously. however it is necessary that the operators have good judgment tempered by experience to know what simplifying assumptions can be made to get the problem into a practical channel without materially changing the end result.

T. B. Montgomery: Usually, I think when we buy electrical equipment, especially rotating machines, we can put a measure of them in terms of pounds of copper and pounds of iron, as an indication of what we are buying. Obviously in this kind of a problem we are brought to the conclusion that such equipment cannot be measured in these terms as indicated by the work that these papers have shown us that is being done on modern control.

As further comment, it seems that in the sixty-cycle systems, we were trying to get an answer to the protection of the system, that is the dynamic characteristics of transients. As a result, systems are well protected today. Closed cycle control systems are in a similar position at present. I think the industry has gone quite a distance in the study, in learning what has to be done to actually get the values of the transients that you have to deal with. Back in the early days we tried to get the characteristics, particularly of a heavy drive, accomplished in large part in the characteristics of the machine. Now we have simplified the machine and are getting the characteristics by external equipment, the control equipment.

W. E. Miller and F. S. Rothe: Mr. Harris and Mr. Montgomery have both emphasized important points in the application of regulating systems to main roll drives. Modern regulating systems do permit more nearly standard machine characteristics. However, one purpose of our paper was to emphasize that the performance of the complete system is dependent upon the characteristics of all the components of the system, and these include the big machines as well as the so-called regulating machines.

Voltage gains are always used in stability studies of regulating systems. However, power gains are important too. It is of advantage for the rotating regulator component to have both high power gain and short time constants. A colleague of Mr. Harris' in a recent AIEE paper defined the ratio of power gain to time constant as the figure of merit of the rotating amplifier. From a stability standpoint, it is desirable that the regulating component of the system have a high figure of merit. If in a system, the high power gain and the inherent high voltage gain are not required, then resistance may be added in series with the input field or quadrature field to reduce the time constant and thus make it easier to stabilize the regulating system. Rotating regulator exciters with their high power gain are thus very flexible components that can be standardized, and yet used in a very wide variety of systems.

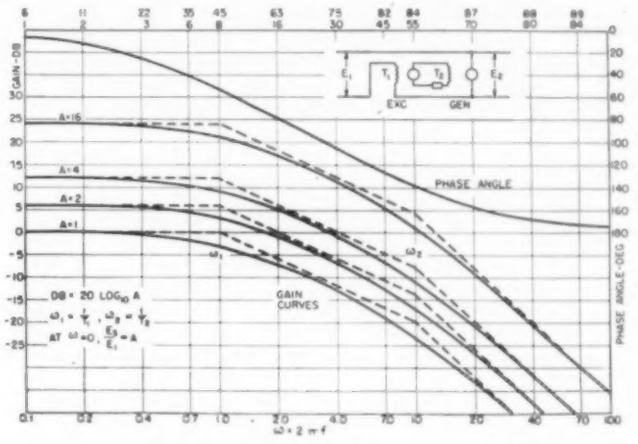


Figure 22 — Open loop frequency response and phase angle plots for two time delay system operating with several values of loop gain.

Mr. Harris has presented a study of the effect of loop gain upon the transient performance of a simple regulating system. Since an example has been proposed, we believe it will be of interest to make a stability study of this system and to compare the performance predicted by the steady state frequency response method of analysis described in the paper with the results shown by Mr. Harris. Figure 22 shows our assumed two time constant equivalent circuit as well as the open loop frequency response and phase shift. Such plots are usually made in terms of Db (Decibels) and ω (Omega, or $2\pi f$). The basic advantage of using ω is that $\omega_1 = \frac{1}{T_1}$, or for the generator where $T_1 = 1$, then $\omega_1 = 1$. For the exciter where $T_2 = 0.1$, then $\omega_2 = 10$. The decibel gain is defined as $Db = 20 \log_{10} A$, where A is the open circuit loop gain as given by Mr. Harris in his Figure 20.

The transfer function for the system is

$$\frac{E_3}{E_e} = \frac{A}{(1 + pT_1)\ \ (1 + pT_2)} \qquad (1)$$

where E_e is the error voltage, or the difference between E_1 and E_3.

Replacing p with $j\omega$, we have

$$\frac{E_3}{E_e} = \frac{A}{(1 + \omega j\ T_1)\ \ (1 + j\omega T_2)} \qquad (2)$$

It should be noted that the Decibel curve of the previous above equation was plotted first as a series of straight lines and then corrected. It is customary to consider that over the range $\omega = 0$ to $\omega = \frac{1}{T_1}$ that:

$$\text{Db} = 20 \log_{10} A \Bigg]_{\omega = 0}^{\omega = \frac{1}{T_1}} \tag{3}$$

and from $\omega = \frac{1}{T_1}$ to $\omega = \frac{1}{T_2}$ that:

$$\text{Db} = 20 \log_{10} \frac{A}{\omega T_1} \Bigg]_{\omega = \frac{1}{T_1}}^{\omega = \frac{1}{T_2}} \tag{4}$$

From $\omega = \frac{1}{T_2}$ to $\omega = \infty$, the magnitude is:

$$\text{Db} = 20 \log_{10} \frac{A}{\omega T_1 \quad \omega T_2} \Bigg]_{\omega = \frac{1}{T_2}}^{\omega = \infty} \tag{5}$$

The slope of the lines is approximately 6 Db per octave (or everytime the frequency is doubled) per time constant.

The phase shift is also plotted to completely define the performance. At $\omega = \omega_1 = \frac{1}{T_1}$, we have:

$$\frac{E_3}{E_e} = \frac{A}{(1 + j1)\ (1 + j\frac{T_2}{T_1})} \qquad \textit{or}$$

$$\frac{E_3}{E_e} = \frac{A}{(1 + j1)\ (1 + j0.1)}$$

The phase shift due to the first term is 45 degrees and that due to the second term is 6 degrees. The total phase shift at $\omega = 1$ is, therefore, 51 degrees.

It is not necessary to calculate the phase shift at each frequency if a "Bode Ruler" is used. If such a ruler shown in Figure 23 is laid over Figure 22 with the 45 degree point first at ω_1, then at ω_2, phase shifts for various values of ω can be noted on Figure 22 and then added to obtain the total phase shift. The values have been marked at the top of Figure 22 and added to obtain the plot of phase angle.

Corrections to the straight approximation of the Db curve are also given on the Bode ruler. These corrections can also be marked and the exact plot obtained as shown by the solid curves.

If the phase shift is less than 180 degrees at the value of ω where Db = 0, then the system will be stable. Since each time constant can cause only a maximum phase shift of 90 degrees, a system with only two time constants will always be stable.

However, such a system can still have damped oscillations, and it is possible to predict the magnitude of the first peak and the frequency of the oscillations without solving the differential equations. The ratio of controlled variable, c, to the desired value r is given in this paper as:

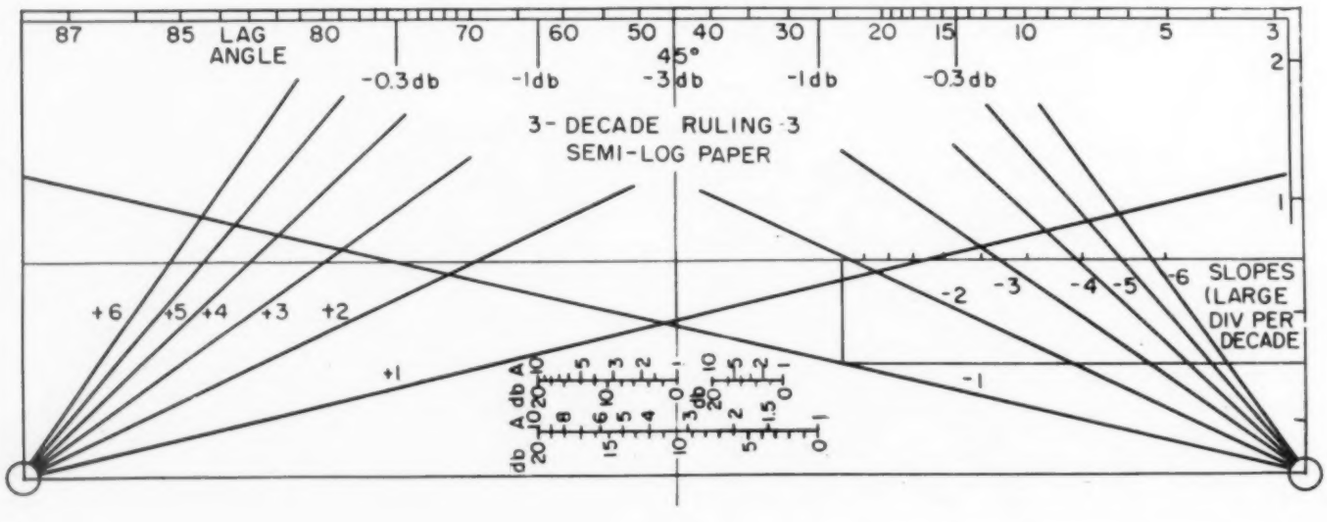
$$\frac{c}{r} = \frac{\frac{1}{H(p)}}{1 + \frac{1}{G(p)\ H(p)}} \tag{6}$$

For the system under discussion, where feedback H(p) is unity, this reduces to:

$$\frac{E_3}{E_1} = \frac{1}{1 + \frac{1}{G(p)}} \tag{7}$$

where:

Figure 23 — Bode ruler for use in plotting frequency response and phase angle curves.



$$G(p)=\frac{E_3}{E_e}=\frac{A}{(1+j\omega T_1)\ (1+j\omega T_2)} \qquad (2)$$

Figure 24 shows a "Nichols Chart" from which it is possible to obtain values of the ratio $\frac{E_3}{E_1}$ as well as the phase lag of E_3 with respect to E_1. The Nichols Chart is a solution of equation (7) as a function of values of open loop gain in Db and phase angle in degrees as found in Figure 22 for each value of frequency ω. Plots of the frequency response or ratio $\frac{E_3}{E_1}$ (with $E_1=1$) for the values of A under consideration as a function of ω are shown in Figure 25. To obtain $E_3=1$ at small values

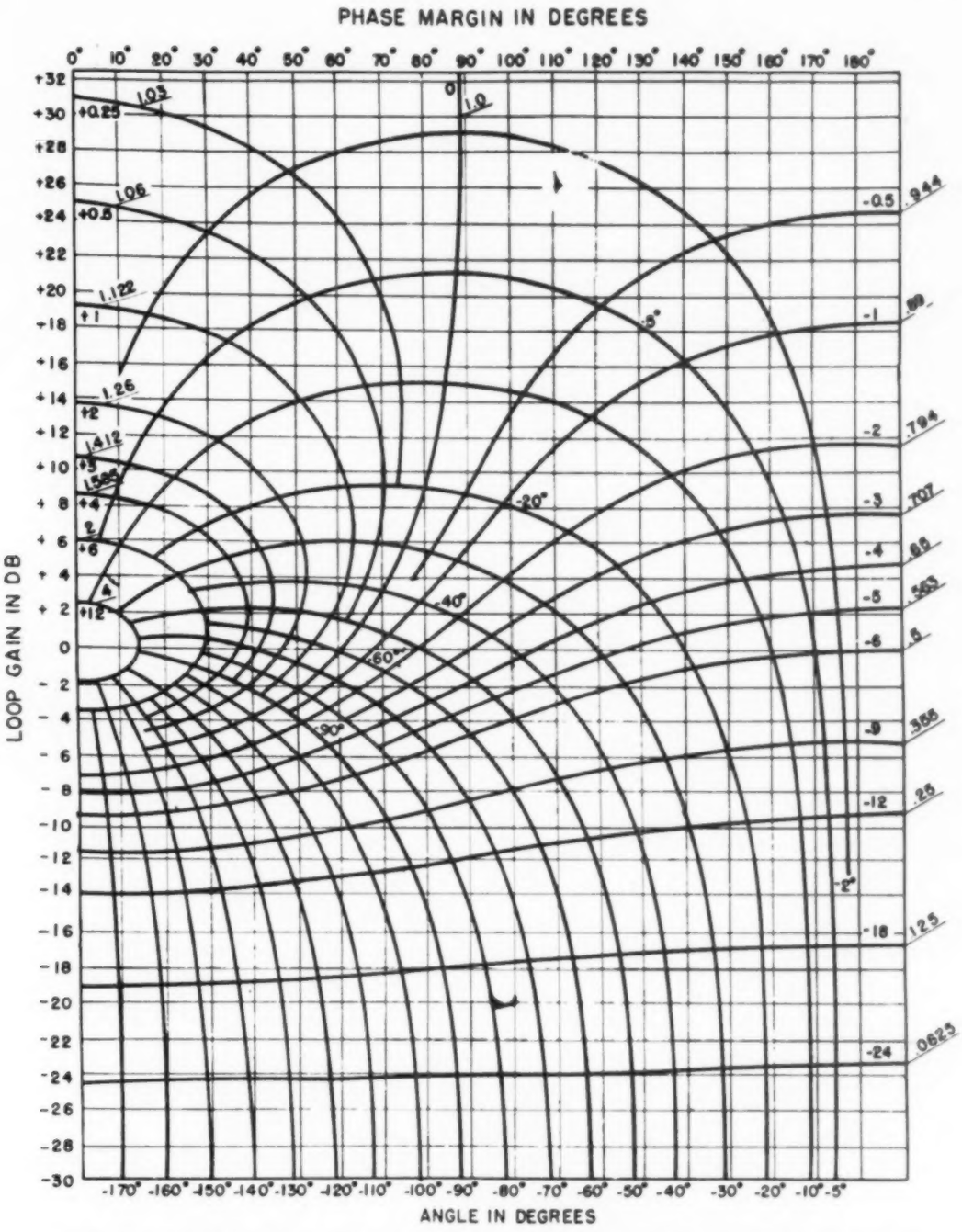


CHART OF CONSTANT PHASE ANGLE AND CONSTANT AMPLIFICATION CONTOURS ON THE DB PHASE MARGIN DIAGRAM

VALUES OF AMPLIFICATION IN DB — IN ACTUAL VALUES

TRACED FROM ORIGINAL BY N.B. NICHOLS RAD. LAB. M.I.T.

Figure 24 — Nichols chart for use in obtaining closed loop system response from open loop system response.

of ω, all plots on Figure 25 would have to be multiplied by $\frac{A+1}{A}$.

The system transient overshoot should be less than the peak in the frequency response curve and the system natural frequency of oscillation should be approximately equal to the frequency at which the peak occurs. Let us see how good the correlation between the two methods of analysis is. Referring first to Mr. Harris' Figure 20, the final change in generator voltage in all cases is 10 volts. For A = 16, the peak is 13 volts, or the ratio is 1.3. For A = 4, the peak is 11.5 volts or the ratio is 1.15. For A = 16, the period of one oscillation is approximately 0.58 seconds or $2\pi f$ equals approximately 10.8.

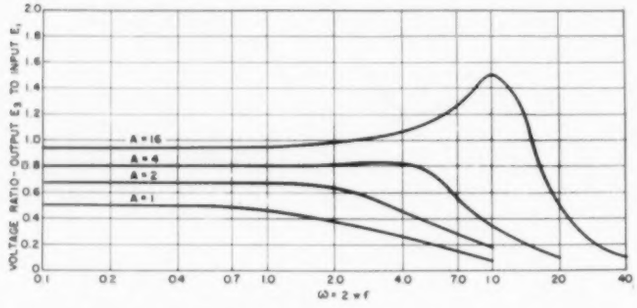


Figure 25 — Closed loop frequency response for a two time delay system operating with several values of loop gain.

Referring now to Figure 25, it is seen that for A = 16, the peak voltage ratio is 1.6 and the frequency of oscillation is $\omega = 10$. For A = 4, the voltage ratio is 1.025. The correlation appears to be good for A = 16. However, for A = 4, the frequency response method predicts a system transient overshoot of approximately 2½ per cent rather than the 15 per cent shown on the transient curve. It is also unusual to have so much overshoot with the regulator gain so low. Therefore, let us calculate the transient performance for the assumed equivalent two time constant circuit shown in Figure 22. If equation (1) is substituted into equation (7) and the values of $T_1 = 1.0$, $T_2 = 0.1$ substituted, and the equation simplified, the resulting system differential equation is

$$\frac{E_3}{E_1} = \frac{10A}{p^2 + 11p + 10(1 + A)} \qquad (8)$$

The solution for A = 16 is

$$\frac{E_3}{E_1}\left(\frac{1+16}{16}\right) = 1 - e^{-5.5t}\left[1.102 \operatorname{Sin}(11.8t + 65^0)\right] \qquad (9)$$

The solution for A = 4 is

$$\frac{E_3}{E_1}\left(\frac{1+4}{4}\right) = 1 - e^{-5.5t}\left[1.59 \operatorname{Sin}(4.45t + 39^0)\right] \qquad (10)$$

Plots of the lefthand side of equations (9) and (10) are shown in Figure 26. The numeric ratios are included to correct the curves to the same output level. This means that as A becomes smaller, the values of E_1 must be increased to compensate for the larger system excitation or error voltage as previously explained in the paper.

It should be noted that Figure 26 shows the initial rate of increase of generator voltage, E_3, to be zero. This is as it should be for a two time constant system since the initial generator field current is zero. It will also be noted that the overshoot for A = 4 is approximately 1 per cent checking that predicted by the analysis made by the frequency response method. The correlation is good, and has been proved to be good by similar sets of calculations, even on very complex systems.

Careful consideration must be given to saturation in system components. If the ceiling voltage of the regulating system components is not adequate, the system will saturate and may not perform as expected. Saturation must be considered in making system studies. Many times, it is not necessary to operate all machines entirely in the unsaturated range; it depends upon the performance required.

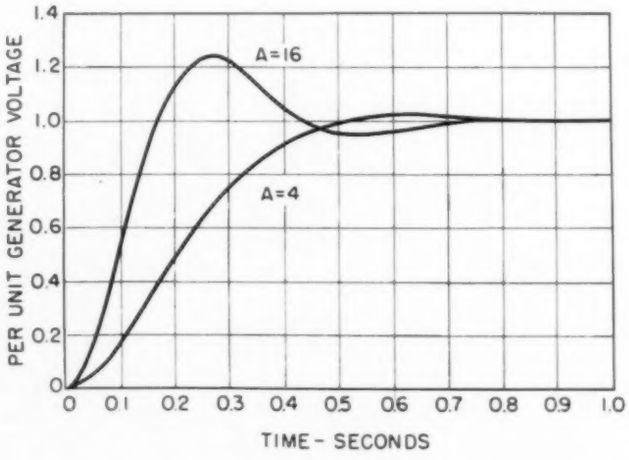
Figure 9 illustrates the relationship between ceiling voltages and steady state voltages in the voltage control system of a reversing blooming and slabbing mill. The figure was plotted from an oscillogram, and the system was adjusted to give some slight amount of oscillation so as to show up the time lags in the various components of the regulating system. The circuit is shown in Figure 8.

The amplidyne exciter, GVCE, reaches a ceiling voltage of approximately 11 times steady state requirements. The generator exciter, GE, reaches a peak voltage of 5 times its steady state value. Such forcing is required to obtain fast reversal of a large blooming and slabbing mill motor.

The question of fast reversal of blooming and slabbing mills is one that has come up very frequently of late. If any advantages are to be obtained through fast reversals, it must be remembered that the auxiliaries also have to be fast. After the material gets out of the mill, it has to be reversed, may have to be turned on edge, and the screws have to be brought down. Unless these auxiliary functions can be taken care of very rapidly there will be no advantage in fast reversal of the mill.

We have a mill that has been operating for several years now with a base-to-base speed reversal of about 1.25 seconds. Charts have been taken periodically with-

Figure 26 — Transient response to a step function change for a two time delay system for two values of loop gain.



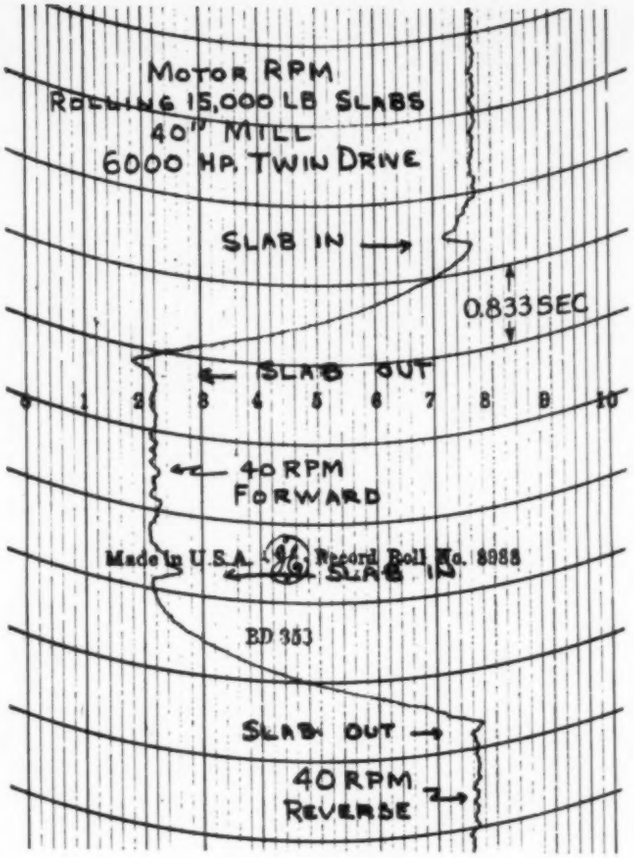


Figure 27 — Photo-electric recorder chart of motor speed taken while rolling 15,000-lb slabs at base motor speed of 40 rpm.

out the knowledge of the operators rolling the slabs, and we find that they do use the fast reversal to advantage. They are able to deliver a fifteen or twenty thousand pound slab at about 40 rpm, reverse the mill, reverse the slab, bring the screws down and enter at 40 rpm in about 1.4 to 1.6 seconds. They have been doing that for quite awhile, and they really like the fast reversal. But as said before, they gain because the auxiliaries are fast along with the mill and thus they can improve their tonnage. This performance is shown in Figure 27.

Applications of magnetic amplifiers always arouse interest in the steel industry. However, as pointed out in the paper, the magnetic amplifier is inherently a non-reversible current amplifier, while the rotating amplifier is a reversible voltage amplifier. At 400 cycles, the magnetic amplifier is considerably faster than the rotating amplifier. However, at the present time, application of magnetic amplifiers to reversing drives, or fast decelerating drives results in a more expensive equipment as well as a system with a lower over-all power efficiency.

The inking oscillograph recorder charts of the magnetic amplifier tandem cold mill system are not labeled as to IR compensation adjustment. As explained in the paper, if the per cent IR compensation adjustment is set at zero, then the motor time constant is effectively outside of the regulating loop and will have negligible effect upon the voltage regulating system. The voltage regulating system will show essentially the same transient performance whether the motor is operating at full field or at weak field.

When 75 per cent IR compensation is used with the motor operating at weak field, it is possible that the error voltage might reverse or the generator voltage overshoot with the actual speed change remaining critically damped. A large accelerating current is required to force the change in speed. Effective IR compensation during transients translates current into generator voltage to force the change in speed. Figure 19 shows an emergency stop for a rotating regulator controlled tandem mill and illustrates this point.

WANTED!

There is a constant demand for copies of "The Modern Strip Mill", published by the Association of Iron and Steel Engineers. If your copy is not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BUILDING, PITTSBURGH 22, PA.

OPERATIVE RESULTS OF ONE-WAY FIRED RECUPERATIVE SOAKING PITS

By E. H. CAUGER
Chief Combustion Engineer
Wheeling Steel Corp.
Steubenville, Ohio

and

J. C. STAMM, JR.
Field Engineer*
Wheeling Steel Corp.
Steubenville, Ohio

. . . new pits improved quality, increased production, and reduced costs . . .

▲ IT became evident some years ago that Wheeling Steel Corp. in its Steubenville plant needed new and improved soaking pits. In this paper it will be unnecessary to elaborate on the reasons for this situation, but it may serve a useful purpose to discuss them briefly.

Eight rows of regenerative pits were handling approximately 90,000 tons of hot ingots and as much as 6000 tons of cold ingots per month. There was a growing demand for more production by the open hearth and it was felt that the rolling mills could handle more steel. The pits were unable to maintain a constant supply of satisfactorily heated ingots under those conditions. It had been necessary to roll cold slabs from the furnaces to permit the pits to accumulate enough tonnage to roll on a succeeding turn. This often resulted in delays. The pits were constantly pushed to their capacity, often to the point where they were being used more as "reheating furnaces" than as soaking pits. This created overheated ingots with resulting "washed" and "cut" steel; also, minor skin defects in the steel were aggravated. Summing up reasons then, quality of production stands out foremost as the need for improving the soaking pits.

It appeared that new automatically controlled pits would improve the situation by:

1. Minimizing the human factor in temperature control. Overheating should disappear and washing be minimized. Desired temperatures could be assured and more uniform scale conditions should result.
2. Improved heating should increase the capacity even with the same number of pits and should help operating problems especially when heats were bunched by the open hearth.
3. Bottom making delays would be reduced.

Various types of pit installations were investigated. Finally, taking into consideration the limitation of space, a decision was reached to purchase the one-way fired recuperative pits now installed. Resulting quality of production and economy of operation have well justified the installation.

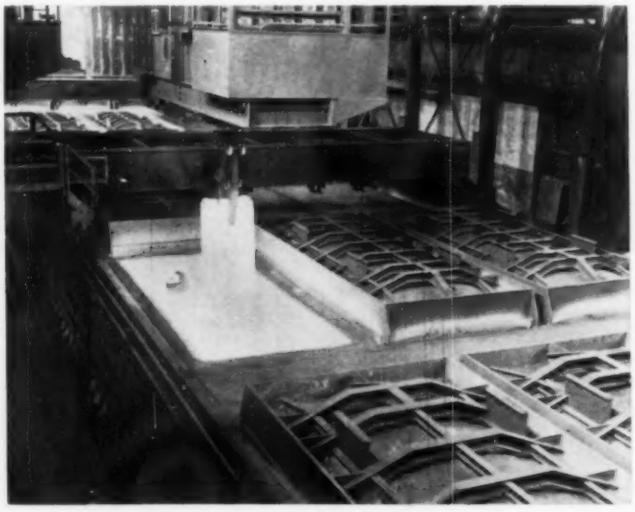
*At time of paper presentation. Now with Kaiser Steel Co., Fontana, California.

SOAKING PIT INSTALLATION

The installation now consists of six three-hole batteries of one-way fired pits, and a single old regenerative block of three holes. Inasmuch as all six new batteries are alike, the following description and specifications will be for one battery only.

Each hole is 8 ft 6 in. wide by 20 ft 8 in. long with a depth of 11 ft 8 in. (total depth). The side walls and end walls of the pits are constructed of 18 in. of 97 per cent silica brick, and 6 in. of insulating brick and block. The walls between the pits are constructed of silica stone. The sand seal and top of pit walls are super-duty

Figure 1 — Covers are of sprung arch type.



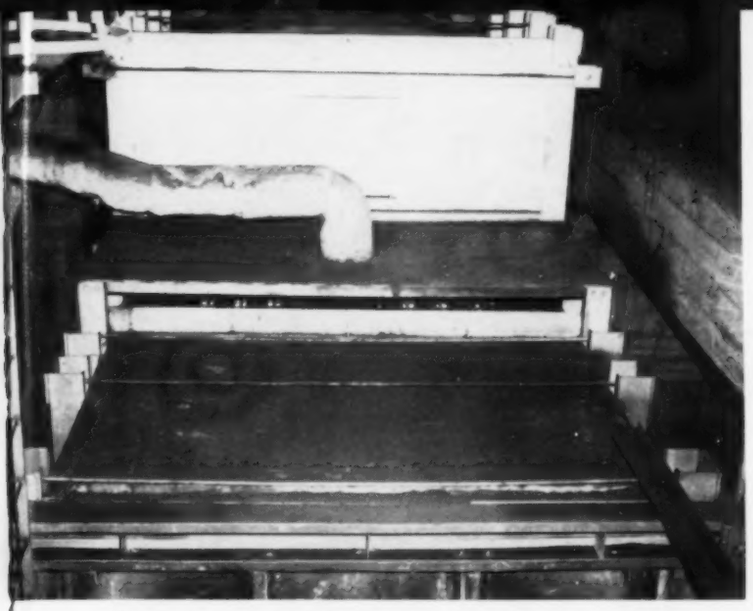


Figure 2 — Waste gases are carried through a tile recuperator.

clay blocks. At the slag line for a height of 22½ in. and a thickness of 9 in., the pits are lined with unburned chrome brick. The bottom of the pits consists of 2½ in. of insulating brick, and 11½ in. of No. 1 firebrick covered with 18 in. of coke breeze.

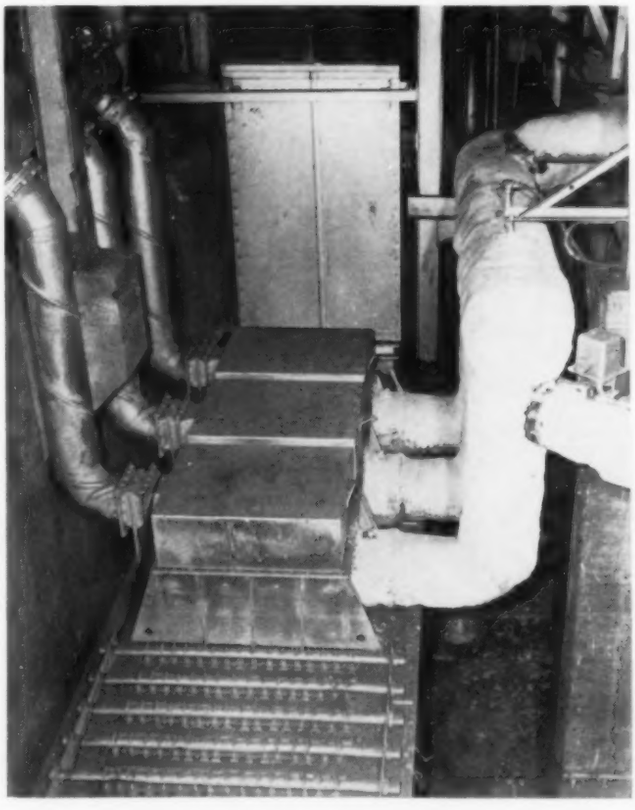
The rear walls of the waste gas downtakes are faced with 13½ in. of super-duty clay brick and the balance of the downtakes are high duty (first quality) firebrick all backed with 4½ in. of insulating brick.

The covers (Figure 1) are rectangular in shape, and of the sprung arch type. Cover refractory consists of super-duty clay brick with an effective depth of 9 in. and covered with 2½ in. of insulating cement. The structural frame is of ample strength to carry the brickwork. The cover is lifted at four points by the cover carrier thus minimizing the bending moments of the frame. Since the first installation, December 19, 1948, no cover repairs have been necessary.

There has been one experimental cover installed with 3000 F insulating brick which, to date, has performed very satisfactorily.

Each pit is equipped with one burner (Figure 1) located in the end wall at the top of the pit. The fuel is burned above the top of the ingots and burned gases are exhausted through ports located in the end wall below the burners.

Figure 3 — A metallic recuperator is also used.



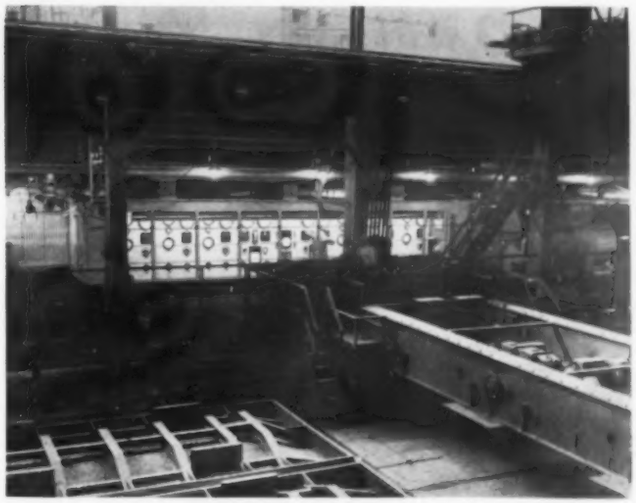
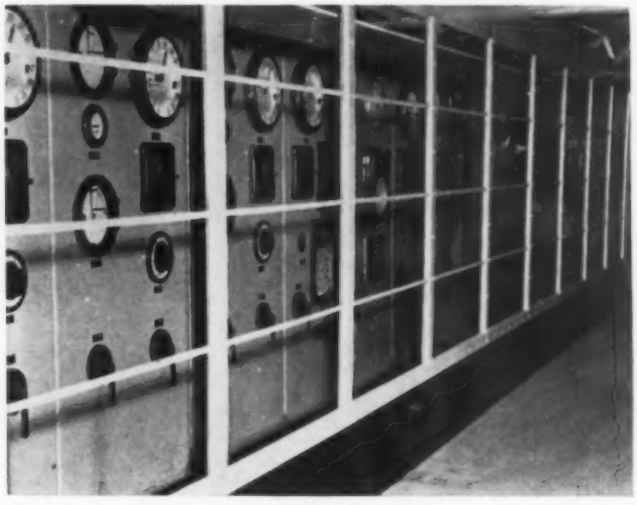


Figure 4 — Panel control house handles two batteries of pits.

A flue common to three pits carries waste gases through a tile recuperator (Figure 2) then through a metallic tube recuperator (Figure 3) and then to the stack. The stack serves two batteries. It is steel shell, brick lined, 175 ft high, 7 ft inside diam brickwork.

Two cover cranes of the gantry type are provided for handling the pit covers. The automatic electrical controls on the cranes are such that once a cover is lifted, the fuel to that pit is cut off until the cover is replaced. Due to lack of space in this installation, covers can be opened in only one direction.

Figure 5 — Instrument panel for one pit.



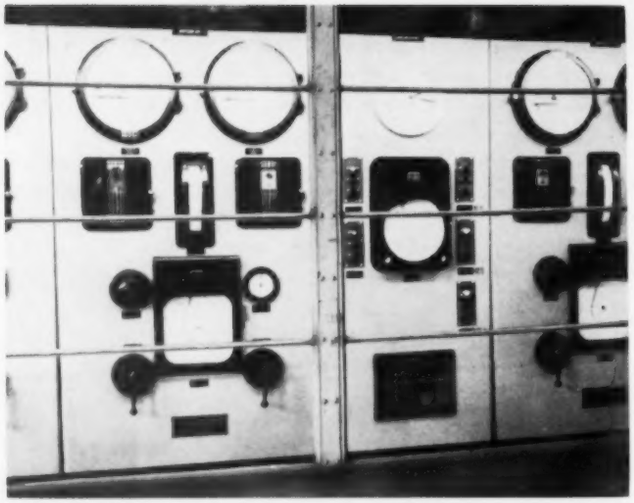


Figure 6 — Master panel for one battery.

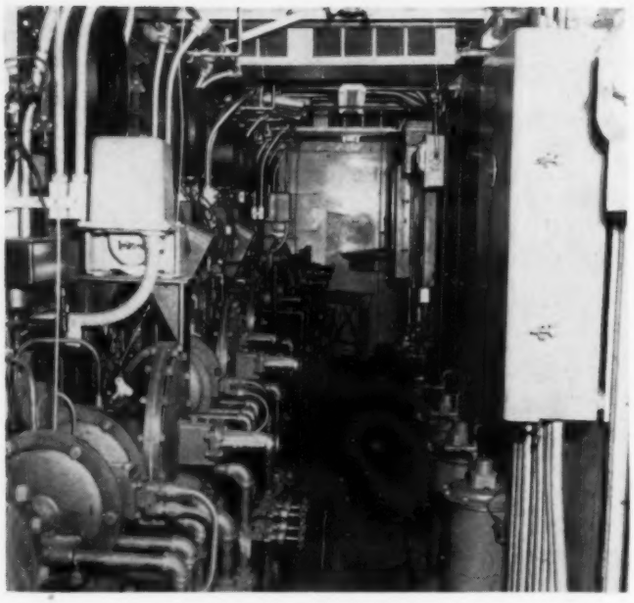


Figure 7 — Hydraulic controls are shown on back of panel.

Four turbo-compressors, each having a capacity of 4300 cfm, supply combustion air at 40 oz pressure.

Each of three control houses of steel and glass, ventilated with filtered air, contain panels and hydraulic controls for two batteries of pits (Figure 4). One instrument panel for each pit (Figure 5) has the following instruments: 1. temperature control and recorder; 2. fuel flow recorder; 3. pit pressure recorder and control; 4. fuel-air ratio control.

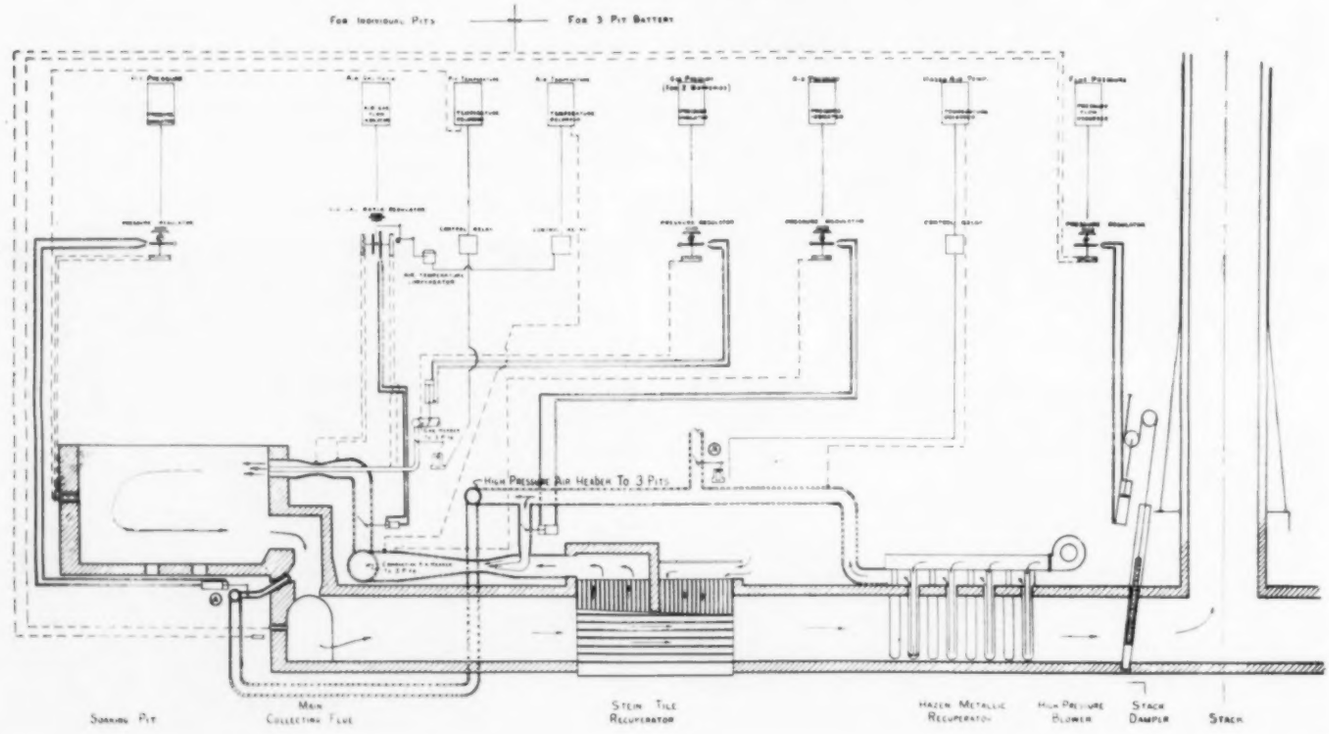
A master panel (Figure 6) for each battery contains: 1. recuperator temperature control and recorder; 2. combustion air temperature recorder; 3. stack damper control; 4 Flue pressure indicators; 5. gas pressure indicator; 6. air pressure indicator; and 7. oil pressure gage.

Stands back of the panel hold the hydraulic operated controls for the pits (Figure 7) whose operation will be described next.

DESCRIPTION OF CONTROLS

Temperature — The pit temperature is recorded and controlled by electrically operated instruments (Figure 8). The impulse comes from a platinum thermocouple located in the end of the pit opposite the burner about four feet down from the top center. As the temperature of the pit reaches the control point and the steel reaches its soaking point, the fuel flow is automatically reduced,

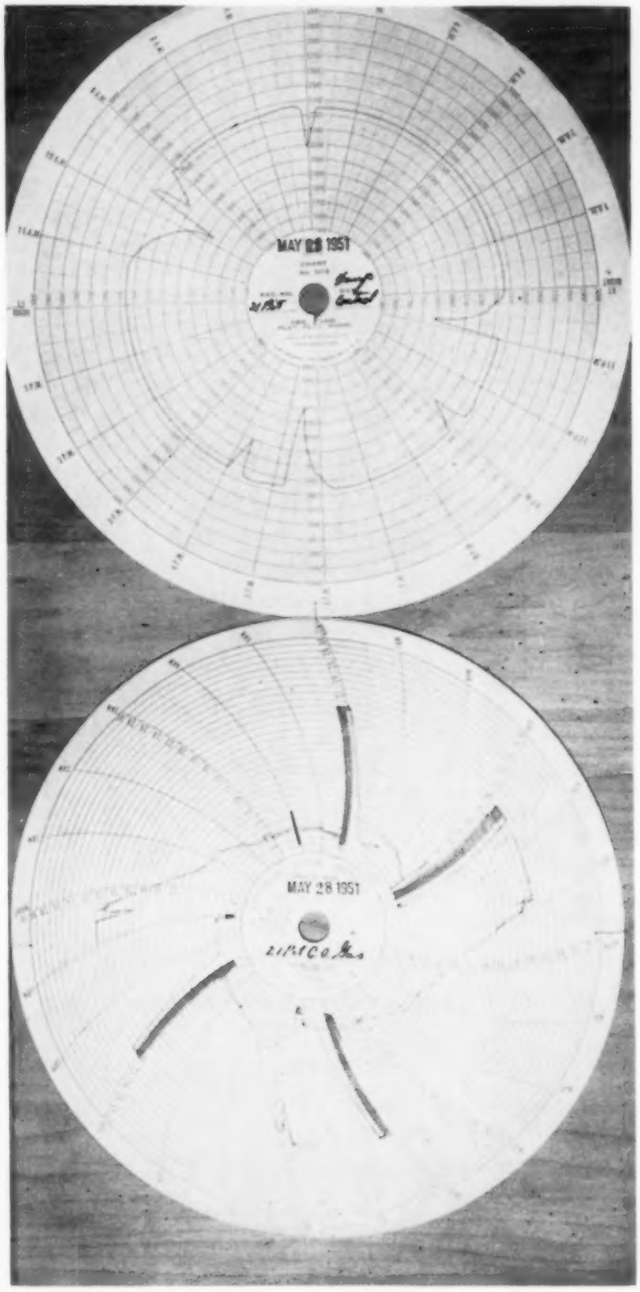
Figure 8 — Schematic diagram of pits and controls.



dropping to approximately 3000 to 4000 cfhr, where it remains constant. Figure 9 shows this clearly.

Fuel-air ratio — The fuel-air ratio is maintained at approximately 1 - 1.2 gas to air ratio throughout the whole range flow by hydraulically operated controls, i.e., as the gas flow drops, the air is cut in proportion to maintain this ratio. This represents approximately 10 per cent excess air. This ratio is checked periodically by fuel maintenance men and has been found to date to provide an adequate means of atmosphere control. Coke gas is used as a fuel with a net value of 489 Btu. Combustion air (Figure 8) is supplied by turbo-blowers as mentioned in the previous section. This air is maintained at 40 oz pressure and passes through a metallic recuperator which raises the temperature to approximately 450 F. This then passes through a jet which aspirates atmospheric air through a tile recuperator. The air from this recuperator raises the total air temperature to 900 - 950 F. This temperature has been found to be best for the type fuel now used. While higher air preheat temperatures can be maintained, they result in a too sharp flame, and in ingot washing.

Figure 9 — Fuel flow and pit temperature charts.



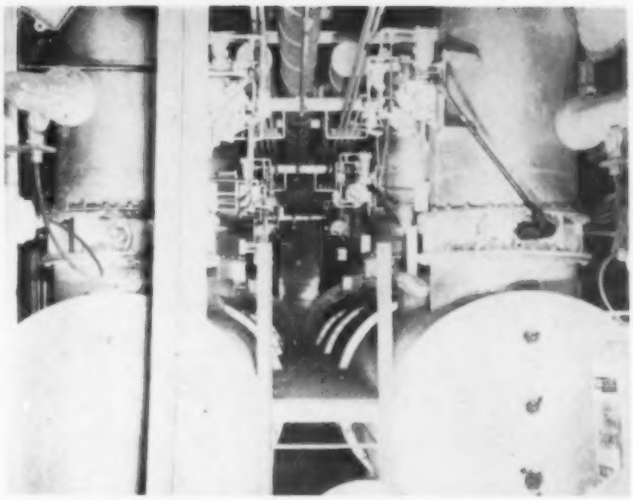


Figure 10 — Air headers and air jet cylinders are located in basement.

A temperature recorder and controller on the metallic recuperator keeps the air at a maximum of 450 F temperature by pulling more air through the metallic recuperator and dumping it into the tile recuperator. The air pressure at the burner is maintained at 2 - 2½ in. water.

Gas pressure — Gas pressure is maintained by hydraulic regulators in the main header at 10 oz. A safety shut-off system for gas flow is provided, activated by static pressure in the air header. The controls are set to allow a maximum flow of about 22,000 - 24,000 cfhr of fuel to each pit.

Pit pressure — Pressure in each pit is maintained at between 0.06 to 0.08 in. water positive pressure. This pressure is controlled, first, by a quick acting stack damper which operates to maintain a pressure in the flue of about 0.04 in. water, and second, by a pair of air jets acting as a damper located in the downtake flues of each pit. As a cover is opened, and the pressure drops, air comes through the two jets (Figure 8 and Figure 10) to maintain a positive pressure in all three pits of that battery. As will be noted on the charts in Figure 11, pressure does drop in all three pits when the cover of one is lifted, but experience has shown that this drop does not greatly affect the heating operation of the other pits.

Movable jets of alloy steel, which worked in and out as the cover was opened were tried on the installation of the first battery. However, it was soon discovered that these caused a good deal of maintenance difficulty and that stationary jets were just as satisfactory. Therefore stationary jets were installed in all pits.

Bottom-making — The pits are designed with a cinder hole opened hydraulically, through which any slag and caked braize can be dropped into the basement below. A pneumatic-tired tractor with scoop attachment operating in the tunnel (Figure 12) carries the waste products to an elevator which dumps them into a railroad car on ground level. Crane operator's tools do the clean-out work and the breaking up of cinder in the pit

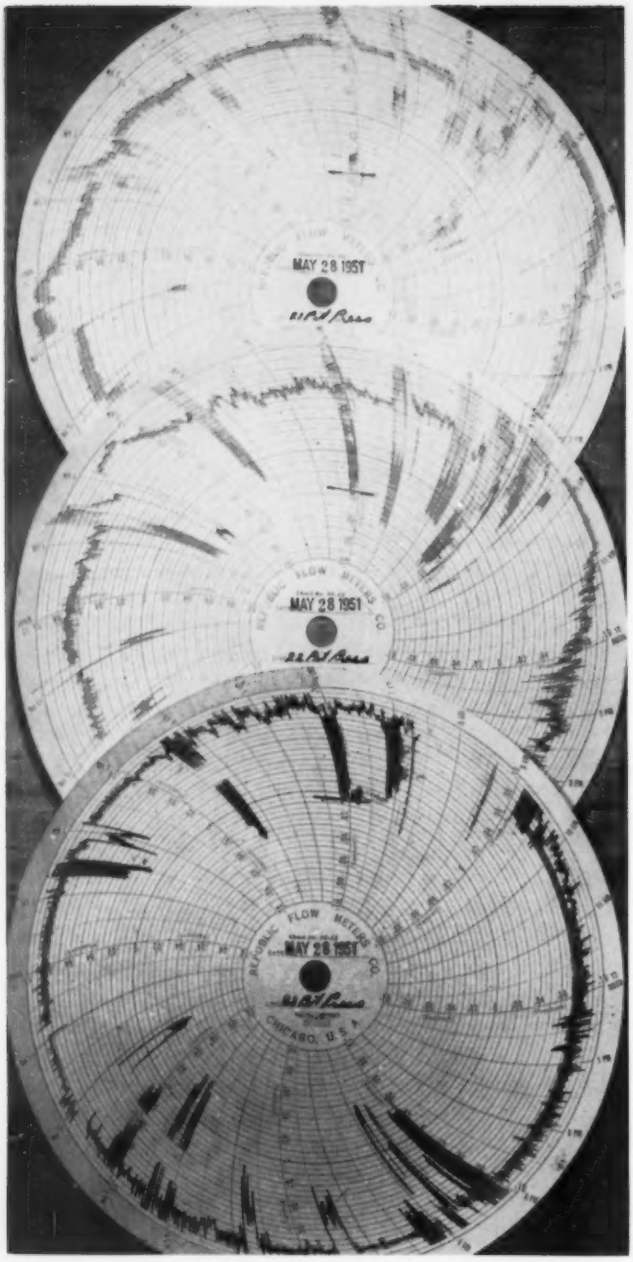


Figure 11 — Pit pressure charts are shown for No. 7 battery.

bottoms. Experience has shown that bottom making in these new pits consumes a negligible amount of time. Less than one half of one per cent operating time is lost in the process of cleaning out a pit and adding new coke braize. The pits have been operating on this schedule since their installation.

OPERATIONS

Table I shows the ingot sizes and ingot weights, the type of mould or pour height and the number of each size commonly charged in the pits. A schedule of sizes charged is set up as the mill gradually changes during the month from one width to another. For example, during the month of May, 1951, chosen for study for this paper, 26 × 42 in., 24 × 48 in., and 24 × 50 in. were rolled the first part of the month. Following this, narrow ingots, 24 × 30 in., 34 in. and some 38 in. and

Figure 12 — Pneumatic tired tractors operate in cleanout tunnel in basement.

39 in. were rolled. Large widths were again rolled from the 20th to the 22nd after a major mill repair period during which roll changes and repairs to compensate for general mill wear were made. From the 22nd to the 28th smaller widths were again rolled and the month ended with the blooming of large size ingots.

A regular schedule of repairs for the hot strip mills occurs approximately every ten days. The rolling from the pits is scheduled so as to start upon wide sizes after the repair day.

Figures 13 and 14 give an idea of the manner of charging ingots. All ingots are charged big end down

TABLE I

Ingot Sizes and Weights Commonly Charged

Size, in.	Weight, lb	Type mould or pour height	Number usually charged per pit
24 x 30	11,200	Mechanical capped—full 65½ in. pour	10
24 x 30	11,500	65 in. pour	10
24 x 30	13,100	Killed	10
24 x 30	12,100	Rim	10
24 x 34	13,800	Mechanical capped	10
24 x 34	13,500	65 in.	10
24 x 34	14,100	Rim	10
24 x 38	15,200	Mechanical cap and rim	11
25 x 39	16,500	Mechanical cap and rim—corrugated	12
26 x 42	16,000	65-in. pour	10
26 x 42	17,200	70-in. pour	10
24 x 48	18,600	65-in. pour	8
24 x 48	20,100	70-in. pour	8
24 x 54	21,200	65-in. pour	8
24 x 54	22,100	Full pour	8
24 x 60	24,000	68-in. pour	6
24 x 60	26,000	70-in. killed	6

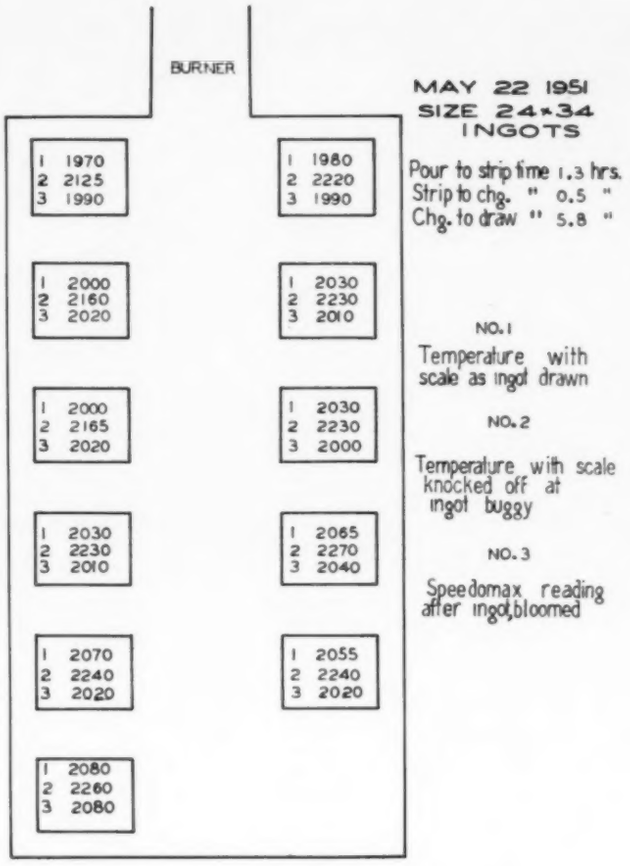


Figure 13 — Diagram gives data for charged pit with temperatures at drawing.

Figure 14 — Ingot is being charged into pit.

along the side walls, generally lengthwise, but in any case maintaining an open path through the center of the pits. It has been found this center must remain open to permit free sweep of the flame, otherwise washing of ingots results.

Control temperature for almost all heats is 2340 F with some few set at 2380 F. High silicon heats are held in the pits for one hour before fuel is applied, and steel is said to be ready for rolling one hour after the gas flow has dropped to its minimum flow and has remained fairly constant. Figure 9 shows this. In the specifications set up for these pits by the builder, the capacity of each pit when heating 12 - 24 in. × 34 in. × 72 in. ingots of mild steel from cold to 2250 F is indicated as 7.5 tons per hour. When charged with steel at 1600 F, capacity is indicated as 15.0 tons per hour.

The fuel consumption when heating the number of ingots as above mentioned to 2250 F is indicated as 1,500,000 Btu per ton and 500,000 Btu per ton respectively. This fuel consumption is based on continuous heating until ready for rolling and does not include holding steel on account of mill delays.

The actual operating results for the month of May, 1951, which was chosen at random, and the definitions of terms used, are as follows:

TABLE II

Results by Pour to Strip Time

Interval hours	No. of charges	Tons per hour		Btu per ton	
		Charge-to-ready	Charge-to-draw	Charge-to-ready	Charge-to-draw
0.1-0.9	291	21.6	14.2	212,000	256,000
1.0	783	16.6	11.1	279,000	337,000
2.0	170	12.7	9.3	395,000	450,000
3.0	34	10.8	8.2	477,000	523,000
4.0	17	10.0	8.2	593,000	635,000
Cold steel	72	6.3	4.9	1,006,000	1,090,000

TABLE III

Results by Common Size Ingots Charged

Interval, Size, in.	Number most frequently charged	No. charges	Tons per hour		Btu per ton		Average tons per charge
			Charge-to-ready	Charge-to-draw	Charge-to-ready	Charge-to-draw	
24 x 30	10	307	14.9	10.9	340,000	388,000	69.3
24 x 34	10	399	17.0	12.3	284,000	326,000	81.6
24 x 38	11	42	18.4	12.1	257,000	303,000	77.7
25 x 39	12	41	19.0	13.1	244,000	290,000	86.4
26 x 42	10	157	16.2	10.0	284,000	361,000	79.5
24 x 48	8	87	15.8	9.5	292,000	370,000	81.3
24 x 54	8	100	18.9	12.6	233,000	280,000	84.4
24 x 60	6	57	17.0	9.5	256,000	332,000	72.9
Mixed	8	111	17.0	11.4	270,000	329,000	99.9

TABLE IV

Results by Number Charged of Each Mould Size

Interval		No. charges	Tons per hour		Btu per ton	
No.	Size		Charge-to-ready	Charge-to-draw	Charge-to-ready	Charge-to-draw
9	30	22	12.6	10.1	403,000	435,000
10	30	104	13.4	9.9	366,000	424,000
11	30	27	13.8	10.7	375,000	416,000
12	30	67	15.9	12.5	320,000	357,000
13	30	23	14.2	10.3	356,000	399,000
14	30	44	16.9	11.7	300,000	354,000
15	30	15	17.5	11.5	282,000	333,000
8	34	13	10.5	8.2	453,000	512,000
9	34	34	15.1	10.6	318,000	367,000
10	34	91	14.1	10.5	343,000	384,000
11	34	48	16.9	12.7	288,000	325,000
12	34	67	19.0	13.7	261,000	302,000
13	34	54	19.7	14.1	244,000	287,000
14	34	87	18.9	13.2	249,000	291,000
15	34	2	24.3	12.5	229,000	290,000
8	38	7	12.9	9.2	283,000	336,000
9	38	4	17.5	12.7	286,000	322,000
10	38	9	22.0	13.8	231,000	280,000
11	38	13	18.2	12.1	265,000	311,000
12	38	8	19.9	13.2	253,000	293,000
8	39	5	14.6	10.6	297,000	339,000
9	39	5	25.0	13.9	188,000	253,000
10	39	4	14.9	10.2	307,000	369,000
11	39	10	18.7	13.4	245,000	287,000
12	39	15	22.1	14.9	220,000	261,000
7	42	10	15.8	11.3	270,000	320,000
8	42	25	14.3	9.1	315,000	420,000
9	42	23	15.8	9.6	281,000	353,000
10	42	98	17.0	10.4	275,000	348,000
11	42	1	19.7	17.2	114,000	139,000
6	48	8	13.8	8.7	340,000	407,000
7	48	9	15.3	13.6	327,000	339,000
8	48	69	16.0	9.1	286,000	372,000
6	54	6	13.8	10.5	315,000	361,000
7	54	12	20.6	13.2	220,000	265,000
8	54	81	19.1	12.7	230,000	277,000
5	60	9	20.0	9.5	241,000	325,000
6	60	46	16.4	9.4	257,000	335,000

RESULTS

The data on Btu per ton and tons per hour is composed of all charges in the new pit for this month of May.

To clarify terms used in this report, the following explanations are offered. All time has been transposed from hours and minutes to hours and tenths. "Pour time," as used in Tables II, III, IV, V, is time finished pouring. All other time, i.e., strip, charge, ready, and draw, are starting times. Charge-to-ready time is taken as time from start of charge to one hour after the gas flow has dropped to its minimum amount. This is determined by the heater and recorded on his daily log sheet. Btu per ton is calculated on the amount of gas recorded by the individual pit meters and using a figure of 489 net Btu per cu ft of coke gas as the basis.

Figures 15, 16, 17, 18, contain three sections each: 1. a bar graph at the bottom showing the number of charges used to determine the points in the top two graphs; 2. the tons per hour; and 3. the Btu per ton. As will be noted, the solid lines represent charge-to-ready figures, and the dotted lines indicate charge-to-draw figures.

The data for these graphs and tables were collected by the hot strip department, and tabulated by the fuel department. The material was then sorted according to various predetermined categories by the statistical department of quality control.

Figure 15 shows an analysis of the results by sepa-

TABLE V

Results by Number of Tons per Charge

Interval, tons	No. charges	Tons per hour		Btu per ton	
		Charge-to-ready	Charge-to-draw	Charge-to-ready	Charge-to-draw
30	10	9.6	5.7	491,000	621,000
40	7	13.0	10.2	328,000	373,000
50	46	13.0	8.0	438,000	502,000
60	253	15.0	10.5	330,000	354,000
70	363	15.4	10.8	310,000	360,000
80	408	17.7	11.6	266,000	326,000
90	203	18.1	12.5	262,000	312,000
100	5	20.8	13.3	283,000	324,000

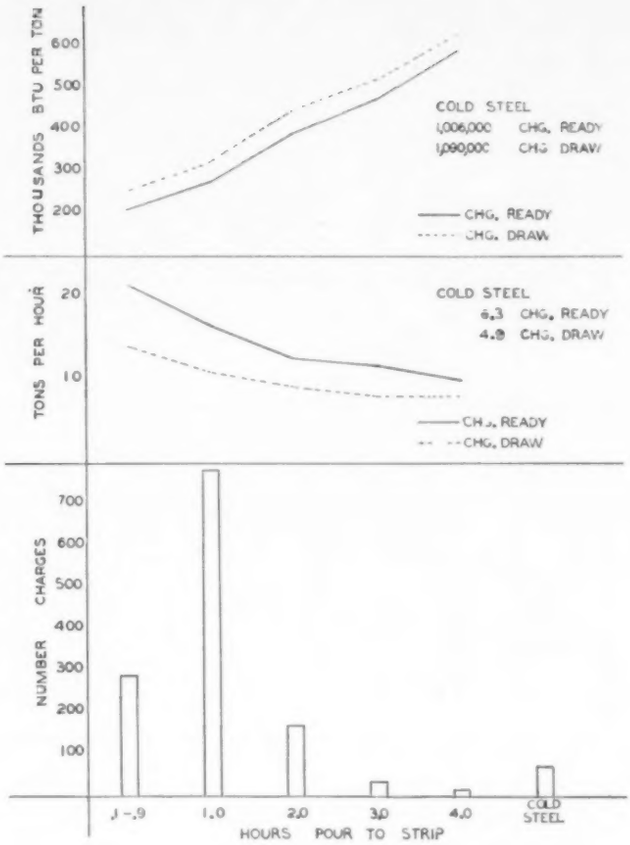


Figure 15 — Graph shows operating results by comparing pour-to-strip time.

rating the charges according to time elapsed from finishing pour in the open hearth to start of stripping the moulds from the ingots. It will be noted that the Btu jumped from 212,000 to 477,000 for charge-to-ready when the elapsed time from pour-to-strip increased from one hour to three hours and the tons per hour for charge to ready time dropped from 21.6 to 10.8. Meager data for longer holding times indicates that this is not common practice. Three charges held for eight hours showed that 754,000 Btu per ton were necessary to bring them from charge to ready, and tons per hour dropped to 9.7. Cold steel charges for this period were included here for comparison. It can be noted tons per hour for charge-to-ready time showed 6.3 and average 1,006,000 Btu per ton for cold steel.

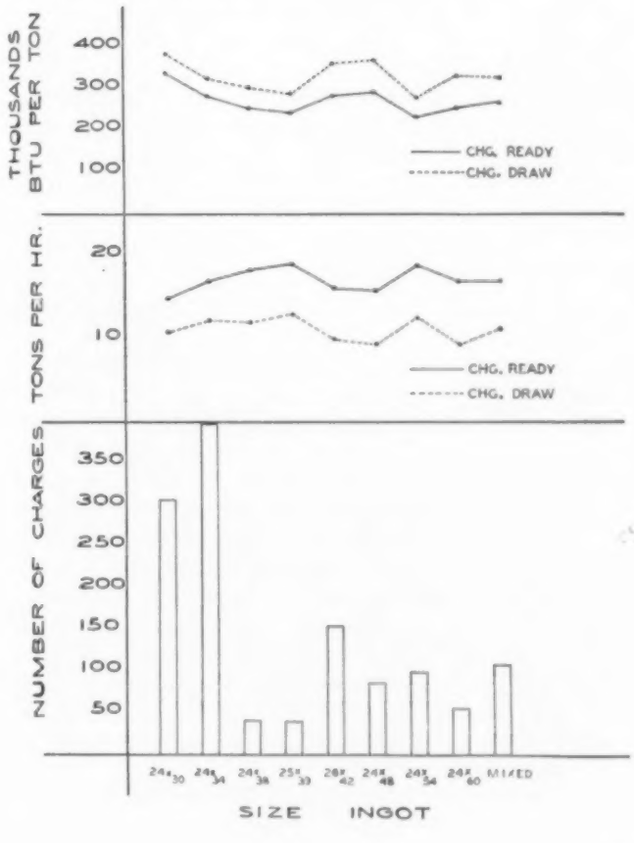
Strip-to-charge time during this study ran from 0 to 5.9 hours. However, out of 1301 charges included, 1263 had less than one hour with the majority being 0.3 hours. Tons per hour decreased from 24.6 at 0 time to 5.8 at three hours. The Btu per ton increased from 205,000 to 1,175,000. The figures 5.8 tons per hour and 1,175,000 Btu per ton are for one charge taken from the tabulations. This necessarily represents an unusual condition rather than an average condition. The pour to strip time in this case was 10.7 hr. Figure 16 breaks down the charges according to common size ingots, 30, 34, 38, 39, 42, 48, 54, and 60 in., and also mixed charges. It will be noted from Table II that the tons-per-hour depends more on the average tons per charge rather than on the size of the ingot. In general, tons per hour increases and Btu per ton decreases up to 24 × 54 in. Then 24 × 60 in. drop off somewhat in tons per hour and a corresponding increase in Btu per ton occurs, but here, as a rule, only six ingots are charged with a resulting loss of tonnage per charge in the pit.

Figure 17 shows a typical result of increasing the number of ingots per charge for one size. Using 24 × 30 in. as an example it will be noted that tons per hour increases from 12.6 with nine ingots charged to 17.5 with fifteen ingots charged. A decrease from 403,000 Btu per ton to 282,000 Btu per ton results. Table IV has corresponding data tabulated for the other size ingots. Other factors that cannot be shown here influence the maximum number of ingots of any size that can be charged, as for example, washing, quality, and operating limitations. The table shows the most efficient number that can be charged from the standpoint of tons per hour and Btu per ton.

Figure 18 shows results by tons charged per pit. Quite logically tons per hour increase consistently from 9.6 at 30 tons charge to 20.8 at 100 tons charge. Btu per ton drops from 491,000 to 262,000 from a 30 to a 90-ton charge with a slight increase for a 100-ton charge. Best operating conditions favor the 80 to 100-ton charges. About 80 tons was indicated by the builders as the best all-round tonnage for which the pits were designed, and results are in keeping with this.

Many operators today are discussing results in terms of "tons per hour per 1000 sq ft of hearth area" rather than simply tons per hour. Taking the 1301 hot charges of this study during May, 1951, as a basis for comparison, the charge-to-ready time, that is, no delays counted in, was 16.4 tons per hr per pit, which is equivalent to

Figure 16 — Graph shows operating results by common ingot sizes charged.



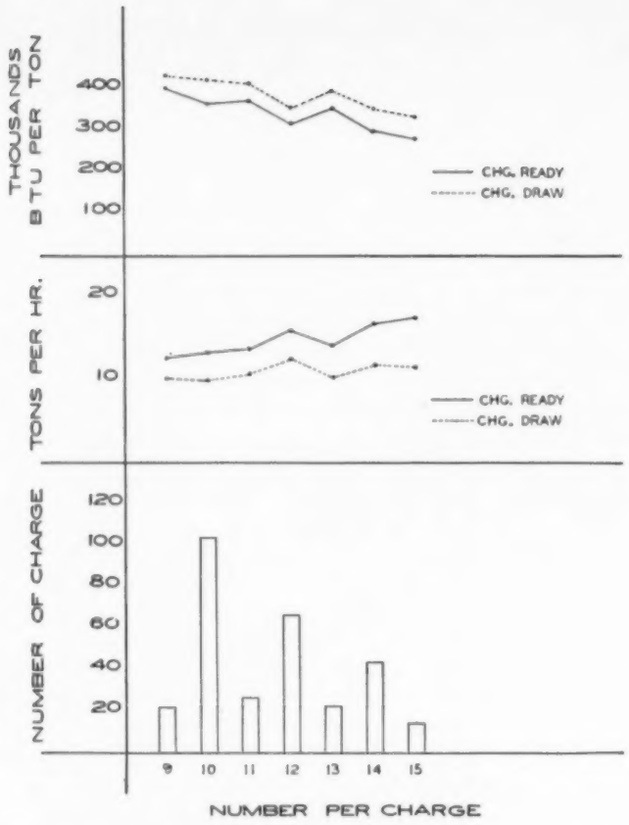


Figure 17 — Graph shows operating results by number of ingots per charge for 24 x 30-in. size.

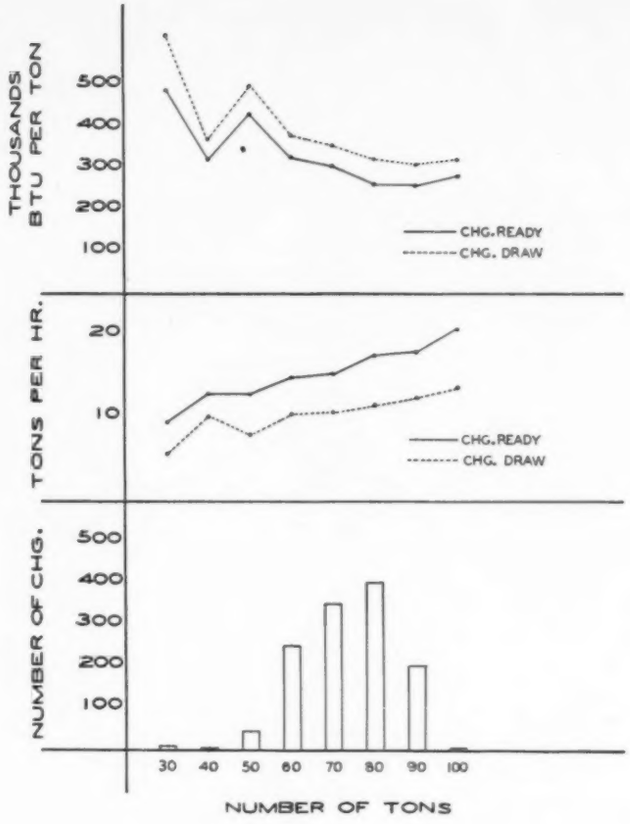


Figure 18—Graph shows operating results by tons charged.

93.3 tons per hr per 1000 sq ft of hearth area. On a charge-to-draw basis, the pits averaged 11.2 tons per hour which in turn is equivalent to 63.7 tons per hour per 1000 sq ft of hearth area.

Figure 19 shows per cent of slabs scarfed for surface conditioning before being rolled into strip. The slabs were divided into mechanically capped, others, and total. Mechanically capped were separately graphed because they are notoriously more sensitive to abuse in heating. They therefore make a more sensitive test for heating. Mechanically capped ingots are generally thin-skinned and blow holes are easily exposed if washing occurs. Consequently better soaking pit practice is reflected in less scarfing of these slabs.

A period of time is shown in Figure 19 before the new pits were in operation, together with continuous time throughout the construction period and down to the present time with the construction program completed. It is noticeable that a consistent drop in the percentage of slabs requiring scarfing occurs, from a high of 26.9 per cent in January, 1949, to a low of 2.5 per cent in May, 1951. A rise followed the period of October, 1949. Part of this is attributable to a work stoppage lasting more than a month, during which time the moulds became wet and cold. A further indication of the improvement in heating is shown by the fact that even though ingot production has greatly increased, the percentage of slabs requiring scarfing still has decreased. There are other factors involved in this decrease in scarfing, such as better open hearth practice and improved mould care.

As expected, the improved heating has resulted in a much better product. Figure 13 shows the temperature of ingots first as drawn from the pit with scale on and, second, with some scale knocked off just before being lowered onto the transfer buggy. It can be noted that the pits are operated so that the ingots in the pit opposite the burner are somewhat higher in temperature than those on the burner end. This is desirable as the temperature control is from the far end and of course it is essential that normally no part of the pit charge is at a higher temperature than that 'seen' by the temperature control. The difference has never been enough to be detrimental to good rolling. These checks were made with an optical pyrometer and therefore some deviation may be due to emissivity and to operator technique, but enough checks have been made to verify the above conclusions.

MAINTENANCE

The fuel department keeps an instrument repairman at the pits seven eight-hour turns a week. Much of his work is preventive maintenance. Constant check on fuel-flow meters, fuel-air ratios, hydraulic system, and related items, are made. This installation uses a special non-flammable oil for its hydraulic system which has proved very satisfactory. Preventive maintenance keeps its loss in the system at a minimum.

An instrument repairman for emergencies is available for the sixteen hour period not covered by the daylight turn.

A previous section mentioned low up-keep time

TABLE VI

Per Cent Slabs Scarfed for Surface

Date	Mechanical caps	Others	Total	Date new pits on
Oct. 17—Nov. 13, 1948	11.99	.....	5.45	
Nov. 14—Dec. 18, 1948	18.41	5.01	6.40	No. 7 row
Dec. 18—Dec. 31, 1948	15.26	5.00	6.74	(Dec. 19, 1948)
Jan. 1949	26.72	2.79	5.44	
Feb.	24.76	2.56	4.90	
Mar.	12.50	2.94	4.69	
Apr.	10.11	2.72	5.95	No. 6 row
May	9.85	2.41	3.69	(Apr. 8, 1949)
June	7.62	1.56	2.60	
July	6.31	2.10	3.12	
Aug.	10.92	3.02	5.15	
Sept.	9.27	3.10	5.02	No. 5 row
Oct.		Work stoppage		(Sept. 6, 1949)
Nov.	15.15	6.88	8.94	No. 4 row
Dec.	8.47	7.27	7.55	(Nov. 18, 1949)
Jan. 1950	7.27	5.96	6.29	
Feb.	13.52	9.70	10.88	
Mar.	17.83	10.36	12.24	
Apr.	14.64	8.49	10.43	
May	14.27	8.25	9.45	No. 3 row (May 19)
June	9.29	6.77	7.36	No. 2 row (June 11)
July	7.43	4.98	5.59	
Aug.	5.41	2.42	3.22	
Sept.	3.66	3.04	3.22	
Oct.	5.35	3.09	3.71	
Nov.	6.31	3.03	3.94	
Dec.	6.20	2.51	3.45	
Jan. 1951	5.88	2.23	3.06	
Feb.	3.49	2.26	2.60	
Mar.	2.86	2.07	2.28	
Apr.	3.79	2.19	2.69	
May	2.50	1.68	1.96	

necessary for bottom-making as compared with pits which were replaced.

The cost per ton of labor and materials for the whole soaking pit layout has been fairly constant for the past few years, yet this is indicative of a decided drop in up-keep costs for the new pits. The costs are not figured on a standard cost basis as some companies' costs are. Therefore, with the all-too-obvious rise in cost of labor and material today, a maintenance cost per ton which has not increased seems to prove a real drop in maintenance costs. The field engineer assigned to this installation by the fuel department makes a monthly report on tons per hour and Btu per ton for each new pit, for the three old pits and for the total shop. A graph (Figure 20) of the information is made and circulated to those concerned. The example shown in this figure is for the month of May, 1951, from which the results for this paper were taken. It must be explained that the fuel figures in this graph contain an added amount, 1.54 per cent in this case, to conform with the amount shown on a master meter total. The Btu per ton still is less than the amount called for in the builder's guarantee.

SUMMARY

In summing up the results of this study the following points are obvious:

Figure 19 — Graph shows per cent of slabs scarfed.

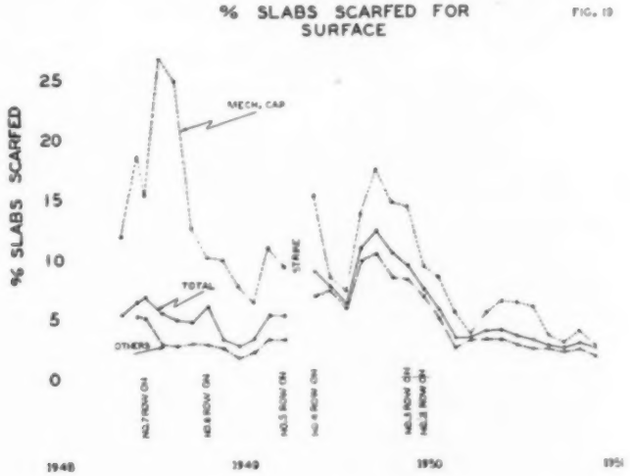
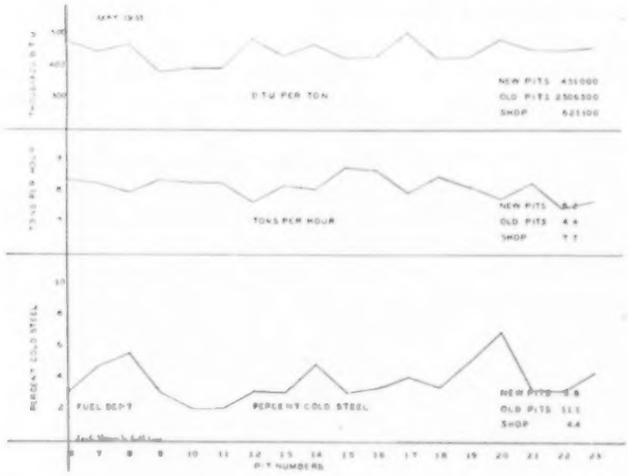


Figure 20 — Graph shows monthly report on pits.



1. The pits have improved the quality of bloomed slabs and finished steel.
2. The present installation of six batteries of new pits and one battery of old pits has been able to take care of the increased production of open hearth ingot tonnage.
3. The tons per hour has surpassed the guarantee of the builder in his specifications.
4. The fuel savings as shown by Btu per ton figures has also surpassed the builder's guarantee.
5. Finally, maintenance costs have decidedly decreased in the face of the rising cost of labor and material.

DISCUSSION

PRESENTED BY

W. H. DAILEY, JR., Surface Combustion Corp., Toledo, Ohio

J. C. STAMM, JR., Field Engineer*, Wheeling Steel Corp., Steubenville, Ohio

RICHARD C. SCHAEFER, Superintendent Hot Strip Mill, Wheeling Steel Corp., Steubenville, Ohio

R. W. STANFORD, Combustion Engineer, Bethlehem Steel Co., Steelton, Pa.

E. T. W. BAILEY, Chief Combustion Engineer, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

E. H. CAUGER, Chief Combustion Engineer, Wheeling Steel Corp., Steubenville, Ohio

W. H. Dailey, Jr.: The authors have made a valuable contribution to the study on the effect of ingot conditioning on blooming mill practice, and this paper certainly indicates an enormous amount of work in its preparation.

Much of the information given in this paper was made available to our company soon after the installation started operation, and as a result of our study of this operating data we have been able to make further improvements in the design and operation of our soaking pits. We would like to discuss some of the design features in further detail.

The flue gases leaving the soaking pits are first passed through a refractory recuperator where they are cooled to about 1400 F before passing through the metal tube recuperator. This temperature is sufficiently low to insure against oxidation or burning out of the metal recuperator under any conditions of operation.

The refractory recuperator is operated under a slight suction so that its pressure on the air side will match very closely the pressure on the flue gas side, thus eliminating leakage. A jet pump is used to draw the combustion air through the refractory recuperator and force it through the piping and burner system, because it is capable of efficiently pumping large volumes of high temperature air to relatively high pressure. The motive power for the jet pump is obtained by compressing cold air to about 2 pounds pressure in a standard cold air blower, heating this air to temperatures from 500 to 1100 F in a metal tube recuperator, and delivering it to the jet through a needle valve which is regulated as required to maintain the desired combustion air pressure in the main distribution header.

In most cases, a single recuperator system serves a battery of two to five soaking pits. This recuperator system does not have to be installed adjacent to the soaking pits and in some instances is as much as 60 to 80 ft away in another building. The averaging effect of the single refractory recuperator maintains nearly normal combustion air temperature even though one or two pits in a battery may be heating cold steel. Recuperator systems are now being designed to give temperatures up to 1400 F.

There is no automatic control for the combustion air temperature. The maximum available temperature is used at all times. In order to maintain proper atmosphere conditions in the soaking pits, the fuel-air ratio regulators are compensated for any variation in air temperature. The compensating devices have worked very well on all makes of controls. We have found that the use of this air temperature compensation control together with maintenance of adequate pit pressure under all firing conditions, including holding at very low fuel input, has practically eliminated the necessity for manually altering air fuel ratio setting under any conditions of operation.

The specified fuel rates were 1,500,000 Btu per ton for cold steel and 500,000 Btu per ton for hot steel. The actual average fuel rate for these conditions based on this paper is 1,006,000 Btu per ton for the cold steel and 300,000 Btu per ton for the hot steel.

According to Figure 18 of the paper the average production rate based on charge-to-ready time for 80-ton charges is about 17.5 tons per hour. Although not covered in detail in this paper, one of the major reasons for the low coke consumption, reduced bottom making time and consistant quality of heating is the accuracy of atmosphere control within the soaking pits. The mechanical design of the soaking pits and the combustion system is carefully co-related with the design of the automatic control devices as follows:

1. The flue system, stack damper and pit pressure regulator are designed to hold an adequate pressure in each pit regardless of the firing conditions so that infiltration of air is prevented even at low holding rates.
2. The air flow is measured directly at the burner by means of a venturi, so that high measuring diferentials are obtained with low pressure loss and there is no leakage of combustion air between the measuring point and the combustion tunnel. The flow measuring differentials are selected to give maximum sensitivity for the particular ratio control devices used.
3. The burners are designed to give complete combustion without separation of the gas and air streams over a flow range of about 10 to 1. You will note from the photograph of fuel flow chart (Figure 9) accompanying the paper, that normally there is a variation of about 7 to 1, during everyday operation.

This installation has shown such marked advantages due to the high accuracy of the automatic con-

*At time of paper presentation. Now with Kaiser Steel Co., Fontana, California.

trols that a program has been initiated to further simplify and increase the accuracy and reliability of these control devices, and the current production soaking pit installations are incorporating these improvements.

Based on a study of the performance data from this Wheeling installation, further improvements have been made on the pit pressure regulation system; finally resulting in the elimination of the individual pit pressure regulation jets.

Study of the data in this report and other data which has been made available to us by the Wheeling Steel Co. shows that the principal reason for the variations in ingot and slab temperature as shown on Figure 13 is the drop off of pit temperature due to opening the covers to draw the ingots. Typical temperature control charts shown in this paper (Figure 9) show that during drawing the soaking pit wall temperature drops about 300 F.

As the first step in investigating this phenomenon, we determined the effect of reversing the order of drawing. This resulted in a similar temperature drop off. Those ingots which were drawn first were the hottest and those which were drawn last were the coolest in each case, regardless of whether the drawing started at the burner end or at the far wall. The next step was to investigate the possibility of holding the pit wall temperatures at higher values during drawing. It was found that improvements in operating practice would help this to a minor extent, but that major improvements could be made by speeding up the action of the automatic temperature control and improving the limit switches and contact devices to allow fuel to be fired a higher percentage of the time when opening and closing pit covers. Several installations have been made with the high speed control devices and in some cases it has been possible to reduce the minimum drop of pit wall temperature during drawing to about 150 F. This has cut the temperature differential of ingots and slabs in half. We have not secured enough operating data, however, to determine whether this improvement warrants alteration of automatic control devices on existing soaking pits.

It has been found possible to rebuild soaking pit installations 10 to 15 years old, incorporating many of these design features and operating practice improvements so that the quality of heating and availability approaches that of the Wheeling installation. Essentially these alterations have included simplification of automatic control devices, elimination of flue dampers for individual pits, and improvements to refractory recuperators.

J. C. Stamm, Jr.: I might say that cold steel is really cold steel.

Richard C. Schaefer: We regard all ingots as "cold" that have been stripped for 24 hr; much of the "cold" steel used in obtaining the figures in the paper, came to us from outside sources.

R. W. Stanford: The exceedingly low fuel rates obtained, 262,000 Btu per ton, possibly suggest that the ultimate has been reached. I would like to raise a question of the effect on the finished product if higher preheated air temperatures were used. Realizing that it has already been stated that a temperature of 950 F for preheated air was found to be the best for this fuel, and that any temperature in excess of this would cause serious operational troubles, would it not be possible to decrease total fuel input and compensate for this decrease by a higher air pre-heat temperature?

Another question, and one that is possibly connected with the previous one, is the general subject of maintenance on the metallic recuperator. Has there been any corrosion, erosion or splitting of the tubes?

In the description of the pits, it was noted that the division walls between the pits were constructed of silica stone, whereas the outside walls were constructed of 97 per cent silica brick. Is there any evidence to show superiority of either of these over the other? Has it become necessary at any time to patch or make repairs on the stone walls? If so, were these repairs carried out with stone or brick?

This paper points out that the drop in pit pressure experienced when one cover is opened does not greatly affect the heating operation of the other pits within the battery. What effect do the two air jets have on this phase of the operation, and would it not be advisable to eliminate them entirely on new installations?

One very interesting fact is in connection with the temperatures which we saw on Figure 13. The temperature to which this steel was soaked was 2340 F. The observed temperature of this steel, as drawn with the scale on, averaged about 300 F less than recorded by the temperature recorder, or in the neighborhood of 2000 F. This same steel with the scale knocked off shows a temperature of around 2240 F. We may therefore readily come to the conclusion that the soaked out temperature as read by the temperature sensing device located in the end of the pit, is the temperature of a relatively small area immediately adjacent to this device and has only an empirical value as far as the true temperature of the steel is concerned.

One other point I would like to bring out has to do with Figure 17, which was the chart showing number of ingots charged per pit. Here we see that the tons per hour heated directly, increases with the number of ingots charged with a corresponding decrease in Btu per ton required. It would be interesting if this experiment could have been carried still further in order to see exactly where the curves would turn in the other direction. The results may be foreshadowed by a study of Figure 18 where the graphs show a decided increase in Btu per ton required above 90-ton charge.

J. C. Stamm, Jr.: We have found no trouble with our metallic recuperator and we have been in operation since December, 1948. We have made no patches to the stone walls in our pits and both the side walls and the center walls have held up. We see at present no indication of breakdowns.

E. T. W. Bailey: It was surprising to learn that the pits could not use preheated air over 950 F in spite of being equipped with two sets of recuperators in series which admittedly contain ample capacity to exceed this temperature. It would seem one could bias the combustion controller so as to increase the air-fuel ratio and use the sensible heat in the air to fuel saving advantage. The ingots are encased in an oxide jacket and seem none the worse for this treatment.

An examination of the data submitted discloses that out of 1301 heats 1074 or 83 per cent were composed of

ingots one hour old or less. In order to prepare this steel for rolling, the pits consumed from 256,000 to 337,000 Btu per ton in the form of 489 Btu coke oven gas. In our case such hot steel is in the minority but when received our pits require 150,000 Btu per ton using a 6:1 mixed blast furnace coke oven gas. This 155 Btu gas contains 60 per cent inerts in the form of nitrogen and carbon dioxide which tend to carry more heat with them to the stack. We regard the above a soaking and not a heating job. Why was such emphasis placed on heat recovery equipment when so large a percentage of the steel required only soaking?

When making comparisons of soaking pits one must be careful that one has a common denominator. Quantity figures could be misleading. Our practice is to test a pit's heating ability by charging steel at atmospheric temperature. For example, a 70-ton charge heated with 155 Btu mixed gas is heated ready to draw in eight hours or at a rate of 8.7 tons per hour. This seems to compare with the author's result of 6.3 tons per hour shown in Table II.

Should not one include the extra thermal energy supplied to fans in the form of electricity costing about $2 per million Btu when tabulating fuel quantities and costs?

Is it required to shutdown all three holes in a battery during bottom making or for brick repairs?

E. H. Cauger: Thermal energy supplied by either induced draft or forced air fans should be included in fuel quantities and costs if such practice were to be established as standard in all plants.

J. C. Stamm, Jr.: We can leave two pits on while making repairs in the third pit.

W. H. Dailey, Jr.: Several questions have been asked about the preheated air temperatures used on this installation. There are several factors to be considered in establishing air preheat temperature as a basis for pit design. For example, high preheat temperature without accurate fuel-air ratio control is no guarantee of fuel economy. Combustion air at 1400 F with 25 per cent excess air is no better than 1000 F air with 5 per cent excess, for fuel economy, and a lot worse for scale control.

We are inclined to rate fuel-air ratio control, along with pit pressure control, as a primary factor in soaking pit operations; and we think that for accurate ratio control with hot air, the air flow must be metered at temperature as it enters the burner. This requires accurately machined metal parts operating at preheated air temperature. We also have to know the temperature of that air and compensate for it. These requirements are met by the control scheme on this installation.

In general, the selection of air preheat for high Btu fuels involves an equation between investment and fuel savings, based on the amortization policy for the plant in question. The only limitation on preheat temperatures for this type of installation is over-all economy. There are, of course, installations in the west and southwest, operating with cheap natural gas fuel and with cold combustion air, on which no investment in recuperation can be justified.

With low heating value fuels, preheat is needed to get satisfactory flame temperatures for ingot heating. Because the ratio of flue gas to air with these fuels is large, the recuperator investment for a given air temperature is less than for riched fuels. We are currently using air temperatures up to 1400 F on mixed blast furnace and coke-oven gas fuels.

There is a demand for copies of the following Yearly Proceedings:

1940 **1942**

1941 **1943**

1944

If your copies are not in use please get in touch with us.

ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

How to Select a Hoist for the Job

By C. O. BARNES
Sales Manager, Hoist Div.
Harnischfeger Corp.
Milwaukee, Wis.

. . . . paper presented at fourth biennial Materials Handling Conference sponsored by Westinghouse Electric Corp., at Buffalo, N. Y., October 28 and 29, 1952 . . . .

▲ ALL elements of hoist application should be considered when buying units for specific applications.

In recent years, the types of units that are on the market fall into four general classifications:

1. Light duty electric operated, chain lift hoists.
2. Light duty electric operated, wire cable lift hoists.
3. Heavy duty electric hoists.
4. Individually engineered electric hoists.

The boundaries of each of these classifications are well marked with respect to application. The manufacturers' specifications for units within these classifications should be integrated with the factors of the application to make the best hoist selection.

These factors are, of course, controlled by the user, as is the selection of the hoist. Usually, the various factors of each application may be sorted into an orderly pattern by considering the following basic elements:

1. Type of operation.
2. Maximum loads handled.
3. Amount of lift required.
4. Frequency of operation.
5. Ultimate position of the hoist with respect to loading and unloading points.
6. Type of mounting.
7. Range of immediate coverage.

Two extremes can be discussed to point out conclusively that type of operation is a critical element in determining the hoist to be used. Firstly, consider a general machine shop application in which normal loads are not large and where lifts are usually standard and frequency of operation not critical. The hoist is required to move parts from skids or tote boxes onto machine tools and, in the reverse cycle, to move the finished parts from the machine tools back to temporary storage. Because the part must be spotted accurately into the machine, hoisting speed must be slow enough to prevent sudden jerks which could damage the bed of the machine tool or cause injury to the operator. However, speed of operation must fit into the time study schedule to maintain a minimum type cycle for overall production time requirements.

The position of the hoist with respect to the machine tool and to the skids or tote boxes must be examined to determine the best vertical lift characteristics. For instance, "side pulling" on electric chain lift hoists is never recommended. On cable hoists, side pulls tangent with the drum circumference are limited to the reach of the wire rope; side pulls parallel to the axis of the cable drum are limited to 1-in. to every 1 to 1½-ft drop of the load hook. The obvious reason for the latter is that the wire rope is used as a lifting medium and must spool properly on a grooved drum. Similar limitations are present in chain hoists. Those types using roller chain have flexibility only in one direction. The side plates and roller pins used in assembly of the roller chain prevent bending the chain along the normal axis of the hoist drum, but flexibility of this type of chain perpendicular to the hoist axis is limited only by the frame of the hoist and the amount of chain.

Proper coverage of the horizontal area to be served must be provided by proper mounting of the hoist. It may be lug mounted or it may be hook mounted, either in a stationary position or on a suitable push type, hand racked, or motor driven trolley. The several types of trolleys provide necessary horizontal movement for spotting of loads. To serve a single machine tool, it is often best to use a winging jib crane with enough length to provide complete coverage of the machine tool and temporary storage area. If the hoist must serve more than one or two machine tools, standard monorails can be mounted for a runway and a single beam crane bridge suspended therefrom to provide four-directional coverage.

In definite contrast to the general machine shop type

of application, there are the more rugged applications such as automotive body handling, cupola charging, heavy foundry work, grab bucket, and magnet handling. These applications require detailed planning, since there are definite quantities of materials to be moved in given time cycles. Furthermore, such applications are invariably critical to basic manufacturing sequences.

For example, in a recent hoist application, the hoist cycle required the movement of auto body assemblies carried on conveyors on one floor to be picked up through a ceiling hatch to a conveyor moving on the floor above. Forty-three seconds was alloted to the complete hoist cycle and the operation was continuous. The operation was so critical that this plant purchased two identical hoists—one for immediate operation and the second as a spare to be located in an adjacent position. In case of failure in the operating hoist, the spare could be moved in immediately to take over the cycle of operation without disrupting production. Although the capacity of these hoists was not high, a special hoist was required because of the high speed of operation and the method of handling

Hoists are applied to many rough operations in heavy foundry work such as handling ladles, pouring, pulling moulds, and cupola charging. Each has a critical function in the foundry operating cycle and consequently, each represents a specific problem.

All hoists in foundry work are operated under unusual operating conditions. In some instances they must be protected against heat and in all cases they must be dustproofed. Dustproofing of hoist brakes, normally ventilated, has the effect of reducing the life of the brake lining since there is no direct method of dissipating the heat developed in the brakes. In most cases, oversize brakes adjustable to the torque requirements of the installation are used. The degree-centigrade rise of a hoist motor may serve as a rule of thumb to hoist buyers. Since the motors are rated for a given temperature rise within so many minutes, and since this is directly affected by the number of lifts per hour, the service factor increases with the rating. Controllers, brakes, shafts, bearings, gears, and cables are all built to correspondingly greater performance factors as the time rating of the motors is increased. The following illustrations will be helpful:

A. Motor ratings based on 15 minutes cover motorized chain hoists and small cable hoists. Usually 10 to 15 lifts per hour is the maximum recommended for these economy model hoists. The lift frequency is, of course, subject to the capacity rating of the hoist. The capacities for these types of hoist range from 250 to 4000 lb with lifting distances of 15 - 18 ft. Maximum operating speeds are 20 fpm. These hoists are quantity production items and are manufactured and merchandised as such. They are regarded as hardware items to be handled by mill supply houses and agents where engineering is at a very minimum. The most common uses are in machine shops working off jib cranes, in small receiving docks, in receiving rooms, at small pickling baths, and at small service docks. In other words, this type of hoist has largely supplanted hand operated chain falls where increased speed and mobility are desired. This type hoist largely parallels the application of air hoists where there is a definite need for electric hoists.

B. Motors rated at 30 minutes cover heavy duty hoists of the hoist manufacturing industries' standardized specifications. Usually, there hoists are good for 20 to 25 lifts per hour with lifts up to 40 ft at a maximum of 35 fpm. Beyond this each application should be carefully analyzed for specific characteristics.

These hoists sell at higher prices than those covered in Class "A" and are built to a standard specification. Consequently, they are not considered as strictly off-the-shelf items. For this reason, the merchandising of these hoists is most often under factory supervision, either directly or indlrectly.

Applications for these hoists usually involve further integration of the hoist proper into the composite plant material handling system. Large capacity units from two tons to 15 to 20 tons with speeds from 25 to 75 fpm are used in shipping rooms, receiving rooms, monorail systems with cage controlled hoists, single girder cranes and large capacity jibs. These hoists come into play when operation ceases to be localized and the hoist is projected more and more into complete floor coverage. Many times, service potential is extended by installing an operator cage equipped trolley or crane bridge, etc., but not so far as to come under the category of custom engineered equipment.

Examples of these type applications are found in receiving and shipping rooms, over machine shop floors, in small foundry apparatus of general nature, power houses, moderate assembly line service, and limited forge shop applications.

C. Specialized applications must be individually analyzed for service requirements, method of control, speed, auxiliary handling equipment, duty cycle, and overall production sequences. Standard hoists covered under class "B" can sometimes be used with proper modifications of motor ratings, brake and control design, gear tooth loads, potential bearing life under various load conditions, and other factors. In other instances, special designs must be considered to meet severe or unusual service conditions. In addition, special protection must be considered not only for the equipment but also for the operator and articles being handled. Applications in this category will be found in grab bucket service, magnet service, paper handling with electrical grabs, and skip bucket service.

There is some overlap in capacities in hoists of class "A" and the smaller ratings in class "B," but there is a major price difference between the two classes even though of equal capacity rating. Price differences are basically due to two reasons. The hoists in class "A" are mass produced and are assembled with parts largely common to the entire line of equipment. Class "B" hoists are, in some respects, semi-engineered or produced to a specific order. Also, the material and design are more rugged in class "B" hoists to match the general need for greater service life or higher duty cycles.

Many other applications involve hoists critical to continuous plant production and require duty cycles so rugged that they cannot be filled by standard units. All of these installations must be carefully studied and laid out to insure customer satisfaction. It is always recommended that complete information concerning the application be made available to the sales engineer. A carefully planned installation becomes a successful installation.

HEATING UP OPEN HEARTH FURNACES AFTER REBUILDING

By HOBERT M. KRANER
Ceramic Engineer
Research Department

and

CHARLES N. JEWART
Ceramic Engineer
Lackawanna Plant
Bethlehem Steel Co.

. . . . from a paper presented at 1952 Chicago and Philadelphia regional meetings of the American Iron and Steel Institute

. . . .

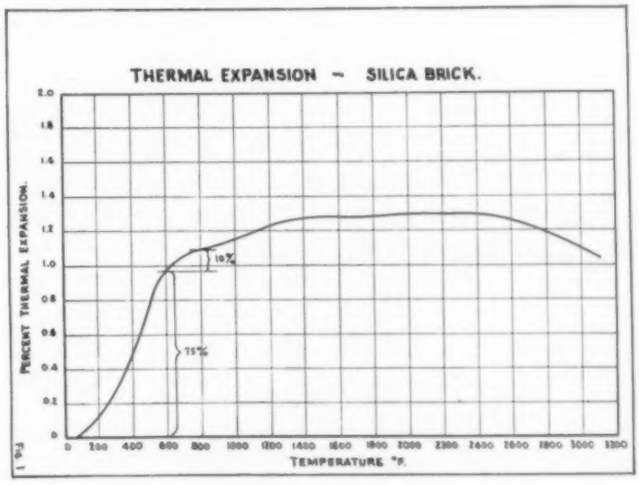
▲ IT has been stated that a little knowledge is a dangerous thing. This saying applies very aptly to certain persistent ideas concerning the use of silica brick. It is well known that silica brick are very sensitive to heat shock. As applied to the above statement, this one bit of knowledge has been extremely costly to the steel industry, not because there is no truth in the statement, but because such a general statement is only a half-truth, and has caused many steel plant operators to resort to unnecessarily slow heating rates to bring furnaces up to operating temperature. The fact is that in certain temperature ranges silica brick are but slightly affected by temperature change, and only in the low temperature range is this brick sensitive to rapid heating.

About 75 per cent of the expansion of a silica brick occurs below 600 F. Between 600 F and 800 F an additional 10 per cent of the expansion takes place, with the final 15 per cent taking place between 800 F and 1400 F. This is shown in Figure 1, which graphically demonstrates the necessity for controlled heating-up through 600 F and the complete insensitivity of the roof brick to the heating rate above 1200 F. In order to ascertain if full advantage was being taken of the latter fact in heating up furnaces in minimum time we have studied (1) laboratory spalling tests on roof brick, and (2) the actual heating-up rates used in open hearth furnaces. From these studies heating-up rates are suggested which have proved to be satisfactory in Bethlehem plants.

In order to determine a rapid but safe heating rate, spalling tests were conducted with header panels of 13½ x 6 x 3-in. roof brick. The panels were insulated on the sides and heated on the end on an electric hot plate at controlled rates. On the basis of these tests we determined that a rate of 140 F per hour was safe in the critical 100 F to 600 F temperature range, after which faster rates could be applied.

One of our plants had been heating up furnaces after rebuild at a fairly rapid rate. It was possible, therefore, to analyze their practice in the light of the expansion characteristics and the laboratory spalling data, to determine how their rate compared with the theoretical rate developed from laboratory data. The laboratory work indicated that even this rate could be improved upon with safety, and faster heating rates over our best practice could be achieved. Improvements were put into effect in all of our plants, with generally satisfactory results. This required the use of thermocouples in roofs, and the elimination of wood fires was recommended. Several of our shops engaged in attempts to follow the proposed schedules using thermocouples at several depths in the roof brickwork for control purposes. Closer supervision of heat-up was necessary in order to maintain recommended heating rates. When one considers that in any plant a furnace is down for rebuilding about three or four times per year the potential savings for the shop are appreciable if it is found possible to make at least one additional heat per rebuild by a faster heat-up schedule.

Figure 1 — Thermal expansion curve for silica brick shows little danger of spalling above 1200 F.



The developments at our Lackawanna plant are of interest. The bulk of our experimental work necessary to establish new heat-up schedules was carried out using the 200-ton furnaces at No. 3 open hearth shop. A more or less conventional heat-up method had been used for heating furnaces after rebuilding before this work was started. The general practice had been to use a hearth burner made of a 2-in. pipe, approximately the length of the hearth with ¼-in. holes drilled every 18 in. This burner was fed by a 2½-in. gas line and was allowed to burn in the furnace from 10 to 24 hours, depending on how far advanced the completion of the furnace rebuild upstairs was ahead of that downstairs.

After the furnace rebuild had been completed, and this burner had been in service for 10 to 24 hours, the end burners were lighted and gas was introduced at rates of from 10,000 to 20,000 cu ft per hour and held for four to six hours before being increased. Roof spalling frequently occurred when 20,000 cu ft of gas per hr was used early in this period.

In order to check the heating rate in the standard practice, thermocouples were inserted in the roof brick to within ½-in. of the hot face. They indicated that a maximum temperatures of only 300 F was being obtained through the use of the hearth burner. This temperature was reached in approximately three hours after lighting. This work showed:

1. That a larger hearth burner, capable of steadily raising the roof temperature to at least 1200 F at a controlled rate, was required, or,
2. That the hearth burner should be entirely eliminated in favor of suitable end burners.

As it was customary to complete the upstairs of the furnace ahead of the downstairs, it was decided to exploit the use of a larger hearth burner. This made it possible to heat the upstairs while work was going on downstairs. The new gas burner was capable of handling up to 30,000 cu ft of coke gas per hr and used compressed air to asperate the gas and for combustion. The flame was directed down toward the hearth which became much hotter than the rest of the furnace.

By controlling the amount of gas and air fed to this hearth burner, it was possible to raise the temperature of the open hearth roof to 1200 F at a rate not exceeding 150 F per hour as recorded by thermocouples inserted in the brickwork to within ½-in. of the inner face of the roof. The important feature of the use of this burner was the ability to attain 1200 F in the roof at a carefully controlled rate to insure against spalling of the brick. This was sufficient to obtain furnace temperature for the ignition of the end burner fuel.

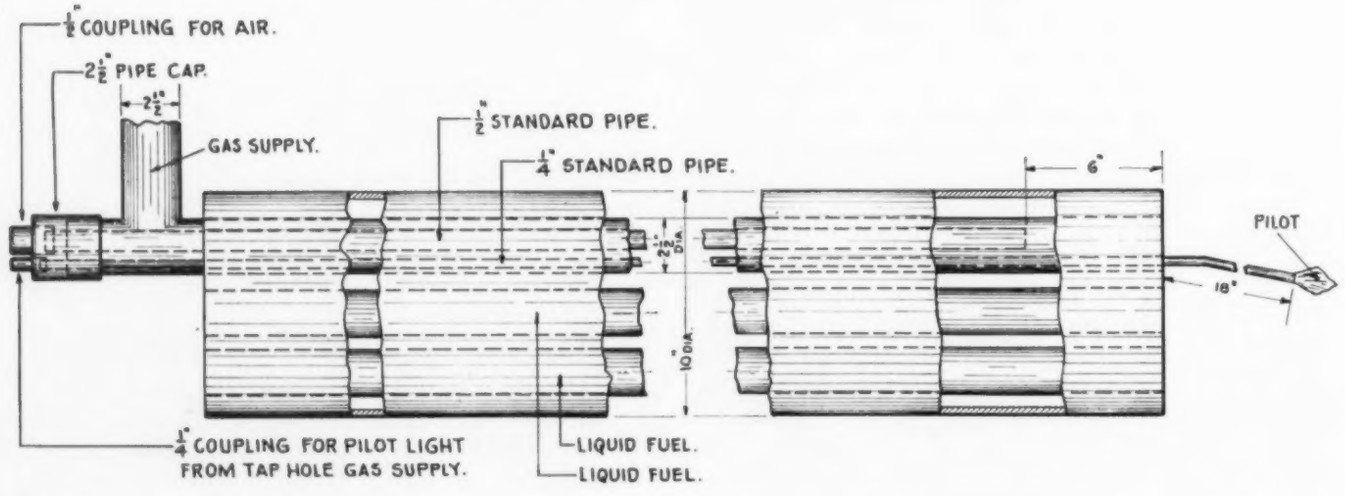
While this hearth burner was on, the furnace doors were closed and the products of combustion escaped through the roof expansion joints and door openings. Slag pocket bulkheads or checker bulkheads were kept open to break the stack draft and prevent the waste gases from going to the slag pockets and sewers where men were still at work.

When the downstairs of the furnace rebuild was complete, and the furnace reversing mechanism had been checked, the furnace was ready to go on end burners. The hearth, roof, etc., were at 1200 F while the checkers, slag pocket, sewers, etc., were relatively cold.

Gas was put on one end burner at the rate of 40,000 cfhr and the furnace was made to draft through the checkers to the stack at the other end. The hearth burner was removed at this time. The furnace was reversed, and gas at the rate of 30,000 cfhr, together with liquid fuel at the rate of 50 gphr was applied. The furnace was made to reverse every five minutes to prevent spalling of the downstairs brickwork. A furnace pressure lower than normal was carried to enable the relatively cold checkers to handle the products of combustion. The consumption of liquid fuel was held at 50 gphr for one hour, after which it was increased at a rate of 100 gphr, every hour, until maximum fuel input was reached. By this method we were able to have maximum fuel on the furnace four to five hours after the rebuild was complete. Two hours after maximum fuel was reached, the reversing cycle was changed to 10 minutes and a normal furnace pressure carried.

Although this hearth burner was instrumental in developing a controlled method for heating up an open hearth furnace, it required considerable manpower to install and remove and was not readily accessible in case of trouble. Efforts were therefore concentrated on

Figure 2 — Heat-up assembly has been installed in open hearth burner.



the development of a means whereby the main burners could be used to obtain the same benefits which had been received from the hearth burner.

The method developed and now in effect uses no hearth burners whatever. All the heat is supplied simultaneously with gas through both end burners which are temporarily revamped. This method has been found to be much simpler and more flexible than the use of the hearth burner. It allows the furnace to be partially charged before the tear-down.

Figure 2 shows minor changes temporarily applied to the standard burner. The regular 2½-in. cap from the gas line of each main burner is removed. An assembly made up of a ½-in. pipe for air supply and a ¼-in. pipe for pilot gas is welded into a 2½-in. cap. This assembly is inserted into the regular burner. This temporary change in the burner provides a means whereby a wide range of gas volume can be used and the direction of flame can be controlled during the heating-up period.

The ½-in. air pipe which extends to within six in. of the end of the main burner gives direction to the flame and supplies air for combustion. The ¼-in. pipe which extends 18 in. beyond the main burner is supplied with gas and is used as a pilot. The gas for the main burners is supplied to both end burners. The quantity needed for each (to follow the scheduled temperature rise) is controlled manually at the panel board.

The air is supplied to each burner through a permanent 1-in. pipe, which is brought down in front of the furnace to a shut-off valve. A 1-in. rubber hose connects this valve and the burner. This air valve allows the operator to control the amount of air necessary to maintain a sharp flame as the quantity of gas is varied.

The temporary burner assembly is only used to bring the furnace safely to 1200 F. At 1200 F the furnace is made to draft to the stack through the checkers on one end. The gas supply to the idle end burner is shut off, the insert is removed and the pipe capped. The burner is then ready for normal operation and is turned on while the insert in the opposing burner is removed. The liquid fuel schedule previously mentioned is followed.

Special thermocouple blocks (two thermocouple brick per roof) are installed at every rebuild in order to measure the temperature of the roof ½-in. from the hot face of the brick. These blocks are installed near the key of the roof above No. 1 and No. 5 doors. Permanent thermocouple wiring has been installed from the furnace roofs to the panel boards. One set of wiring serves two furnaces.

Portable electronic recording instruments mounted on rubber tired buggies are now in use at each open hearth for heating up furnaces after rebuild.

Figure 3 shows the heating-up rate used. This rate was set up so that the lowest rate of temperature increase is applied during the range of the greatest rate of expansion of silica brick. As the rate of expansion decreases, the rate of temperature rise is increased. It is important that the allowable rate of temperature rise must not be exceeded during any period. It is important, if the heat-up should be delayed, that no "catching-up" be attempted as this results in a faster heating rate than is permissible.

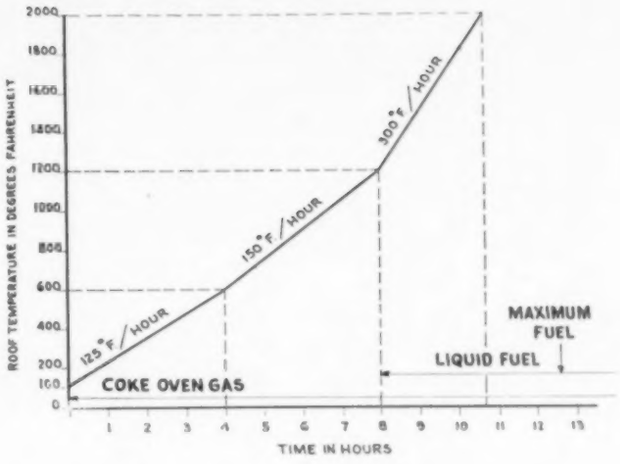


Figure 3 — Sketch shows heating-up rate used.

Special temperature recording charts were developed and are now in use. These include guide lines indicating the desired rate of temperature rise of 125 F per hour between 0 F and 600 F, a rise of 150 F per hour between 600 F and 1200 F, and an increase of 300 F per hour between 1200 F and 2000 F.

Inspectors are now maintained on each rebuild. Their duties include assisting the first helpers to bring on the furnace according to the prescribed heat-up schedule, until maximum fuel is on.

The present practice used in all the Lackawanna shops is briefly as follows:

1. Bottoms are repaired, when necessary, immediately after tapping the last heat.
2. Furnaces are charged with a light scrap charge before rebuilding.
3. Heating is done with gas on a controlled schedule, using both end burners simultaneously.
4. Regular burners and fuels are used above 1200 F.

During 1951, the average time from rebuild complete to tap of the first heat was 22 hours and 22 minutes, with a record low of 16 hours and 50 minutes.

It is estimated that during 1951, this improved heating-up schedule has given us additional furnace availability at the Lackawanna plant equivalent to at least 25,000 net tons of steel per year.

After the recent strike it was possible to heat most of our furnaces by a schedule regardless of the prior number of heats so that they came into production at a scheduled rate.

In order to determine how others had met this problem a survey was made through the offices of American Iron and Steel Institute covering the entire basic open hearth steel capacity in the country (see Table I). Of those contacted 77.5 per cent responded. Twenty-nine shops reported using some sort of heating schedule with rates from 37.9 F per hour to 200 F per hour in the critical 100-600 F range; 16 shops (23 per cent) reported using wood fires for the initial heating; 20 per cent of the shops replying to the survey reported using gas heat in the furnace before work was completed downstairs.

Wood fires, regardless of how they are used, should be avoided in connection with heating any silica brick because of the attendant fluctuating and localized tem-

TABLE I

Open Hearth Heat-Up Survey

Key	No. furnaces	Tons per furnace	Tap to tap, hr	Heats per furnace per year	Tons per furnace per hr*	No. rebuilds per year			Hours to tap		
									Bricklayers through upstairs		Bricklayers through downstairs
						General	Partially	Q.R.	General	Q.R.	General
1	12	105	10.22	748	10.3	1.09	2.33	1.75	38	30	38
2	9	90	12.18	632	7.4	.88	2.22	1.55	90	90	28
3	6	95	11.58	614	8.2	1.00	1.83	2.83	95	95	28
4	12	145	12.03	650	12.0	1.25	1.83	2.42	145	145	31
5	16	199	11.83	662	16.8	.75	4.88	....	32	....	28
6	14	164	11.07	713	14.8	2.79	....	3.01	42	26	36
7	8	178	4.33	1436	41.1	2.00	....	1.00	48	24	42
8	14	142	11.08	690	12.8	2.72	....	2.86	42	26	36
9	14	143	10.97	728	13.0	2.79	....	3.08	42	26	36
10	8	183	10.70	744	17.1	2.75	....	3.25	42	26	36
11	17	75	11.17	725	6.7	2.5	....	2.5	18	14	18
12	3	90	11.50	700	7.8	2.5	....	2.5	19	15	19
13	14	123	10.38	786	11.8	2.6	2.9	....	19	....	19
14	11	233	10.50	760	22.2	1.6	2.4	2.4	23	20	23
15	15	162	10.30	791	15.7	0.33	2.81	2.81	76	17	35
16	13	129	11.45	699	11.2	2.0	....	2.78	33	26	33
17	3	151	4.13	2016	36.5	1.0	....	1.67	50	34	50
18	14	213	11.53	694	18.5	2.0	....	2.93	30	25	30
19	12	69	11.78	682	5.9	1.17	1.75	....	65	....	64
20	13	115	12.00	608	9.6	3.47	....	....	48	....	48
21	9	145	11.50	698	12.6	2.54	1.56	0.11	49	....	29
22	4	115	11.83	613	9.7	0.5	5.0	1.5	34	34	34
23	9	145	6.55	1210	22.2	2.22	....	....	69	....	31
24	10	190	11.15	707	17.0	3.8	....	0.3	29	13	29
25	6	140	13.28	612	10.5	2.74	....	2.34	36	....	36
26	16	130	11.2	737	11.6	2.82	....	2.38	33	22	33
27	5	230	10.45	783	22.0	2.6	....	2.6	30	24	30
28	6	125	9.62	827	13.0	4.0	....	....	33	....	27
29	4	255	11.40	690	22.4	4.0	....	....	37	....	31
30	12	168	9.10	872	18.5	2.33	1.33	....	28	23	28
31	5	194	9.00	933	21.6	1.38	1.38	....	28	23	28
32	11	222	9.68	870	23.9	2.0	1.64	....	28	23	28
33	14	147	10.83	760	13.6	3.05	....	....	31	....	23
34	2	285	12.28	659	23.2	3.15	....	....	36	....	25
35	8	149	10.15	818	14.7	2.75	0.38	....	32	....	21
36	6	220	9.90	824	22.2	3.84	0.33	1.17	31	28	21
37	21	138	12.35	422	11.1	3.15	....	1.43	30	....	24
38	1	239	15.1	522	15.8	1.5	....	4.5	54	40	54
39	1	248	15.5	525	16.0	1.5	....	4.5	54	40	54
40	1	259	15.8	510	16.4	1.5	....	4.5	54	40	54
41	1	251	14.9	539	16.8	1.5	....	4.5	54	40	54
42	6	145	12.7	600	11.4	3.0	....	3.0	56	36	56
43	1	200	13.3	550	15.0	2.0	....	5.0	56	36	56
44	1	280	17.1	350	16.4	2.0	....	5.0	56	40	56
45	8	210	15.4	495	13.6	2.37	....	3.62	60	24	60
46	5	154	15.0	510	10.3	0.8	1.4	3.5	67	30	67
47	10	205	15.6	499	13.1	1.8	0.4	3.5	67	30	67
48	5	250	14.9	445	16.8	1.0	2.0	2.0	53	26	41
49	4	125	14.9	556	8.4	0.25	2.0	2.0	53	26	41
50	9	115	13.1	593	8.8	1.11	1.11	....	80	....	80
51	1	179	15.2	510	11.8	0.83	2.0	....	....	....	72
52	5	147	15.2	510	9.6	0.83	2.0	....	....	....	72
53	2	235	14.17	540	16.6	4.0	....	1.0	45	....	45
54	12	235	14.17	590	16.6	3.5	....	6.0	45	....	45
55	1	235	14.17	570	16.6	3.0	....	1.0	45	....	45
56	5-3¾	153	3.8	1675	2.86	3.8	....	....	43	....	35
57	1¼	....	10.08	....	....	....	....	....	....	....	....
58	1¼	175	13.38	512	13.1	0.73	1.55	....	51	....	46
59	5	173	14.40	584	12.0	3.7	....	....	42	....	34
60	4	225	16.32	456	13.8	4.3	....	....	49	....	41
61	6	65	14.13	641	4.6	4.3	....	....	31	....	31
62	2	550	16.17	500	34.0	....	0.5	1.5	....	....	.....
63	1	465	16.08	500	28.9	2.0	....	3.0	....	....	.....
64	5	400	16.33	500	24.5	0.4	0.2	0.7	....	....	.....
65	5	265	16.67	500	15.6	0.4	0.2	0.65	....	....	.....
66	8	172	13.62	586	12.7	1.74	....	0.29	71	43	71
67	6	142	15.27	487	9.3	0.33	1.0	1.33	105	65	105
68	4	177	14.12	558	12.6	1.25	2.25	0.5	44	29	44
69	4	186	14.12	575	13.2	1.25	2.25	....	49	....	49
70	4	249	13.33	450	18.7	0.75	1.5	0.25	57	30	57
71	12	160	10.58	758	15.1	1.5	1.41	0.08	36	30	36
72	12	142	10.67	719	13.4	0.33	3.48	1.36	31	25	31
73	9	207	10.65	691	17.8	1.44	1.78	0.56	50	30	50
74	12	105	10.12	802	10.4	2.0	....	1.9	40	29	64

TABLE I — Continued

Open Hearth Heat-Up Survey

Key	No. furnaces	Tons per furnace	Tap to tap, hr	Heats per furnace per year	Tons per furnace per hr*	No. rebuilds per year			Hours to tap		
									Bricklayers through upstairs		Bricklayers through downstairs
						General	Partially	Q.R.	General	Q.R.	General
75	15	170	12.92	672	13.2	1.6	1.7	0.6	40	28	40
76	9	205	13.17	660	15.6	1.6	0.9	1.1	42	29	42
77	11	177	10.57	760	16.8	4.7	0.8	0.2	20	....	20
78	14	131	12.55	554	10.4	1.29	1.21	1.86	30	30	30
79	5	173	13.97	586	12.4	2.0	2.0	....	53	....	53
80	8	225	10.35	732	21.8	4.13	....	....	38	....	38
81	8	76	10.31	754	7.4	1.7	1.7	....	60	....	40
82	4	144	11.68	702	12.3	1.5	1.5	....	60	....	40
83	8	145	13.15	575	11.0	1.62	1.37	1.30	60	44	60
84	3	175	13.75	600	12.7	1.66	1.0	0.67	60	44	60
85	7	137	10.50	700	13.0	2.86	2.86	....	48	24	44
86	3	137	11.00	433	12.5	1.0	1.0	....	48	24	44
87	12	150	11.83	605	12.7	0.83	0.83	2.0	74	54	74
88	6	135	14.76	595	9.1	2.0	2.0	0.5	108	....	108
89	6	96	13.86	630	6.9	2.0	2.5	0.3	108	....	108
90	5	129	13.67	565	9.4	0.75	0.75	1.5	94	....	70
91	3	43	10.20	667	4.2	4.0	....	4.0	72	36	72
92	8	125	11.32	635	11.0	2.0	2.0	0.0	32	....	32

Total 706

*Tons per furnace hr = $\frac{\text{Tons per furnace}}{\text{Tap-to-tap (hr)}}$

peratures. Gas fuel is ideal for initial heating as it can be controlled most effectively.

The logical sequence of events after tapping should be:

1. Prepare the bottom for the next heat in order to take advantage of the residual heat in the furnace after tapping.

2. Charge the furnace partially as soon as the bottom has been prepared. On the heat-up, the high density steel scrap dampens the temperature fluctuations caused by the flame and provides excess heat capacity, thereby preventing too rapid heating. To delay charging until the furnace is hot is to waste fuel and production time. There may be justifiable reasons in some shops why charging is not done prior to the tear-down. The survey indicated that 71 per cent of the shops have failed to take advantage of this procedure.

Although our survey was directed toward obtaining information on the time consumed in heating furnaces, it was necessary to obtain certain operating data to evaluate slow heat-up rates in terms of lost steel production. These are shown in Table I. It will be noted that time required to produce the first heat after the bricklayers were finished with the furnace on a general repair varied from 18 to 108 hours. These times show an extreme range of practice throughout the country. As the data includes times for finish upstairs as well as downstairs, some light is cast on the possibilities of applying heat upstairs before the downstairs is finished.

Whether the furnace was charged before the tear-down or after the rebuild it has been demonstrated that a minimum of approximately eight hours is necessary to bring the brickwork up to 1200 F safely. This is the limiting factor, but using data shown in the survey, it would seem that a bogey time of 20 hours could be used as the ideal for getting the first heat out after a rebuild.

A furnace which can tap the first heat 20 hours after the bricklayers are through downstairs will produce over four heats while those which are heated in 50 hours or more are producing their first heat.

As we reported above, we have successfully heated open hearth furnaces to tap in less than 17 hours and averaged a little over 22 hours in 1951. In reply to the survey one shop reported heating and tapping their furnaces in 14 hours after the quick roof was completed.

Thus, using a bogey of 20 hours for each shop and considering the number of rebuilds involved in each shop we calculated the hours saved by the more rapid heat-up. These hours saved were converted into tons of steel production along lines of the following example:

Shop No. 1
12 furnaces
105 tons heat
10.22 hr tap to tap
3.42 general and partial rebuilds per year
1.75 quick roofs per year
38 hr to tap after bricklayers are finished downstairs
30 hr to tap after bricklayers are finished quick roof

Time to be saved on general and partial repairs	38 — 20 = 18 hr
Time to be saved on quick roofs	30 — 20 = 10 hr
Hr saved per year on general and partial rebuilds	18 x 3.42 = 61.6
Hr saved per year on quick roofs	10 x 1.75 = 17.5
Total hr per furnace per year	= 79.1
Tons per hr per furnace	= 10.3

Tons for shop is 10.3 x 79.1 x 12 = 9780 tons lost by slow heat-up.

This type of calculation was made for each shop. Therefore, the result of the survey and such calculation covering the entire industry shows that a total of 613,617 tons for the furnaces reporting, or an equivalent of 780,000 tons for the entire industry are lost by slow heat-up after rebuilds. This is equivalent to the production of five additional 200-ton open hearth furnaces.

By H. F. JACQUART, Master Mechanic, Blooming Mills Dept., Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Planned Maintenance of Blooming Mills

. . . . mill delays and cost per ton have been reduced through the adoption of a planned maintenance program . . . .

▲ NO factor in industry has as far reaching an effect on its economics as its maintenance. In present times, it can be the difference between ordinary and superlative performance; and in a highly competitive market, can be the difference between survival and failure. In our experience we have never found the piece of equipment immune to maintenance. Some may be designed to minimize the maintenance factor, but none has been designed to eliminate maintenance.

Industry in general is aware of the importance of good maintenance. In recent years much literature has been compiled on the results of conducted research and experimentation, all of which have been found helpful. There are no short cuts or rules of thumb to follow to achieve good planned maintenance. Best results, we believe, are obtained where maintenance supervision considers its own problems as special, and plans its program accordingly.

In an industry such as steelmaking where operations are continuous, the most costly part of a breakdown is not the actual repair cost, but the cost of the inconvenience suffered throughout the process flow from the blast furnace to the customer. Often, entire heats, requiring a rigid time schedule to obtain required metallurgical quality, must be scrapped entirely.

Assuming the aforementioned to be factual, it becomes the job of the maintenance personnel to plan the equipment to necessitate the least amount of repairs, at the lowest possible cost, to the best convenience of operations.

The maintenance of equipment referred to in this paper is specifically the blooming mills division of the Jones & Laughlin Steel Corp., Pittsburgh Works. It consists of two 44-in., 2-high blooming mills, one 28-in., 3-high billet mill, one 8-stand 18-in. billet mill, forty-five single fired regenerative soaking pits, two 2000-hp William Todd engines, one 5000-hp Mackintosh engine, one 7000-hp mill drive; and centralized scarfing, sorting and stocking division, all of which are serviced by 31 overhead cranes of various types with capacities ranging from 15 to 75 tons.

It is our opinion that breakdowns due to equipment failures can be held to a minimum. To achieve this objective requires the utmost planning and coordination. Some of the more important factors to be considered in effecting planned maintenance could be the following:

1. Physical and metallurgical design.
2. Lubrication.
3. Inspection program.
4. Regular scheduled repair times.
5. Investigation of equipment failures.
6. Necessary spares and proper control.
7. Equipment performance data files.

Manufacturers of equipment strive to give the purchaser the best piece of equipment that can be designed by known engineering standards and specifications furnished by the customer. However, in writing specifications, purchasers usually enumerate those items required to manufacture specified products, or to achieve an end result, plus the physical boundaries into which equipment must be fitted. Very little, if any, space is used to enumerate maintenance requirements. However, most manufacturers of specialized equipment will tolerate, and even welcome the constructive criticism sure to come after the first drawings are submitted for approval. We feel that the time spent on thoroughly scrutinizing each and every detail of approval drawings, to be sure that the best possible design from maintenance as well as operating standpoint has been achieved, can contribute more to planning its future maintenance than any other one factor. While looking over the physical design, careful consideration must be given to metallurgical specifications as well.

This "scrutinizing" should not be done by any one or two individuals. Both operating and maintenance supervision must be taken into consultations of this nature to achieve the best results, since experience is still one of the world's best teachers. At our plant, those individuals from the unit mechanical and operating foreman up to and including the plant engineering staffs, review such drawings to assure no overlooked details. Every effort is made to meet all operating requirements and to simplify design for both repairs and inspection.

Much progress has been, and is being made in the field of industrial lubrication from a quality as well as a method of adequate distribution standpoint. Given any specific lubrication problem, almost any of the various oil and grease compounders will recommend a satisfactory lubricant for a specific job. It has been our experience, that automatically applied lubrication is superior in every way to the old hand applied methods. We found that removing the human factor resulted in less bearing failures.

Without a simple thorough inspection program, no maintenance could be planned. Some inspections to assure continuous safe operations as well as some to indicate probable replacement times are necessary. They can be classified into two groups:

1. Routine. Those made daily by visual checkup.

2. Special. Those made on a scheduled basis requiring thorough inspections of individual items.

Nearly every maintenance manager formulates his own ideas as to how to set up his inspection program. This is usually geared to his own particular conditions and requirements. At our plant we have a program that I would like to outline briefly at this time, some parts of which have been in practice for some time—other parts were more recently inaugurated.

Our cranes are lubricated by the operators. While lubricating, they make a visual inspection of all bolts, bearings, caps, etc. Any items requiring repair must be reported to repairman in charge immediately. This is done on the day shift only, except where some unusual condition exists, in which case it is done as necessary. At the start of each shift the operator must try his limit stops to be certain they are in working order. Also, before operating, he is required to check his safety lights and fire equipment. He must also maintain a clean and orderly condition in his cab.

Our cranes are inspected thoroughly by repairman; all cranes once every month, and those required to operate continuously bi-monthly. On these inspections, detailed reports are made on available forms and returned to foreman in charge who in turn assign those items requiring correction to the proper personnel.

Our mill equipment is divided into units over which we have repairmen and helpers. These men have routine inspections that must be made each turn. These inspections consist of checking all equipment in their unit for proper lubrication and satisfactory operation. Forms for reporting results of these inspections, together with a list of any material used and a brief explanation of any outstanding happenings necessary to bring to the supervisors' attention are provided.

These forms are made as simple as possible to require the minimum amount of writing by the repairman. Any delays incurred during the turn are also itemized, together with a brief description of the cause of delay.

Many various components of our equipment cannot be readily inspected during operations and must be scheduled to be done on repair turns. These we refer to as "Special" inspections. Some of the items so inspected are main mill drive, motor and control circuits, etc.

We have been testing main drive couplings on a scheduled basis with dycheck, sonoflux and reflectoscope methods of testing for approximately eighteen months. During this time we have saved two potential breakdowns which would have resulted from fatigue fractures had we not discovered them in time. Motor and control circuits are checked for shorts, grounds, and insulation breakdowns on a predetermined time schedule based on our past experiences with the particular items.

We found it cheaper from an inspection standpoint to change motors at specified intervals, rather than attempt anything more than a carbon and commutator inspection in the field. General average of mill type motor changes is approximately nine months; some are slightly longer, some are less. Crane motors average two to four years.

A very thorough engine inspection program had been in force in our department for years. It consists of a very minute inspection of each engine each shift, including a test of overspeed and other safety controls. Flywheels are checked monthly. Cylinders are opened, checked for alignment and reset as necessary bi-weekly. Crossheads and crank pin boxes are checked bi-weekly also. Main bearings are opened for inspection quarterly. All information concerning the engine is maintained in its log book.

Pit furnaces are checked daily, since mechanical damage caused by operations was found to be the greatest source of trouble. Each month a report is made in detail on each pit. The report lists the condition of slag lines, back and front walls, burner ports, top coping, cover and cover mechanism. From this report the repairs for the following month are planned. Only where a complete division wall rebuild is necessary are two pits scheduled off at one time for repairs. Repairs on main flues, recuperators, etc., that involve whole sections of furnaces being down are planned in advance to be made at best convenience to operations.

At one time our repairs were geared to steel availability. It was considered highly undesirable to request a repair turn on a unit if product was remotely available. Only on holidays—July 4th, Labor Day, and Christmas, were we able to plan for repairs. This resulted in a "bailing-wire" type maintenance effort. Some years ago, changes were effected that allowed us to plan an eight-hour repair turn per week on each of major units. It was the first major step in our efforts toward planned maintenance.

Best coordination of maintenance was achieved by having all maintenance foremen attend daily meetings in the master mechanic's office. At these meetings, all maintenance problems are discussed. It is not unusual for the electrical foreman to aid in solving a mechanical problem or vice versa. Briefly, all knowledge is pooled for the common good.

Unit repair lists are submitted at the daily maintenance meetings three days prior to scheduled down time. The lists show the specific jobs contemplated together with their department and inter-department manpower requirements. Since from three to four crafts are involved on any unit's repair turn, each crafts' repairs are discussed at the meeting to assure least interference between the various crafts, and to distribute the limited amounts of crane service to the utmost efficiency. No repair is treated casually. All repair turns are set up to provide men for special inspections. This usually amounts to ten per cent of the allotted manpower.

Originally we had a vast number of repair jobs requiring from two to three shifts to complete. It was nearly impossible for operations to schedule for these without seriously curtailing the entire production flow. Careful study and planning lessened the time on some items, while others required design changes which enabled the jobs to be broken into smaller components. As a result, approximately 75 per cent of the total have been reduced to normal eight hour repair turns.

It is necessary to investigate each equipment failure thoroughly. The reasons which we found were responsible for the majority of failures were design, neglect, and abuse. The failures due to design deficiencies are corrected by analysis of the problem and application of

necessary revisions. Any equipment failure, found to be the result of abuse or neglect are corrected by personal contact on the part of the foreman with offending employe.

As good workmanship is the result of good training and fair dealing, efforts are being made to better educate workmen by reasoning and explanation.

Our experience has been, that as a whole, men like the idea of planning maintenance and cooperate readily. It gives them an organized approach to their work and eliminates the confusion usually evident during breakdowns.

Having the proper spare available when needed is vitally important to continuous operation. Like every other phase of maintenance, it must be planned and controlled. Our spares control plan, with some slight revisions, has been in operation for several years. Briefly, it functions as follows: Unit foremen initiate orders for spares by requisition forms and deliver them to maintenance office. Order is typed and recorded in a card index file by clerk. After approval by master mechanic and department superintendent, order proceeds to engineering department for necessary prints, then to the supplier. Supplier can be either inter-departmental, inter-plant, or outside vendor.

Material received into the department is listed by the clerk on a material received slip, which is given to the foreman. After checking the specified material, the slip is signed by him and returned to the office. From this slip, the clerk revises the on-hand figures and removes the order number the material was received on from the card in index file.

The card index file system is used in the central maintenance office as the master spares inventory. Each foreman keeps ordinary card records in his own office. Periodically these are spot-checked to assure accuracy. They are thoroughly checked bi-annually when the complete physical inventory is taken.

Spares as used are listed on charge-out slips which are taken to maintenance office. From these, the clerk keeps on-hand figures of the spares card correct.

In conjunction with our card system for spares inventory, we also maintain cards for each item to record historical data. These are kept in the card index file card behind each spares record card, and are of inestimable value in planning long range expenditures and repairs.

Each December, the maintenance experience of that year, and that anticipated for the coming year are thoroughly reviewed. From these studies a budget for the following year's expenditure is prepared and submitted to management. The budget is sub-divided into cost centers for each unit, which in turn are broken down to two types of maintenance—special and routine; special being those large in scope and occurring at long time intervals; and routine being those occurring repeatedly and at shorter intervals.

It is evident that the program as described is relatively simple. As stated before, other variations can and have been devised which produce the same result if given full cooperation by all concerned.

For any program to succeed requires the utmost cooperation between operations and maintenance as well as between maintenance supervision and its working personnel. Achieving full cooperation of working personnel being a man-sized job under present labor conditions, every effort is made to keep it on the highest plane. Classes are conducted to educate supervisors in good labor relations. Much is done by encouraging the use of personal relations in dealing with the men. Men are encouraged to know us as men, instead of as the boss. This promotes a feeling of freeness and equality when occasions arise which they feel should be discussed with their supervisors. Much cooperation is gained by recognizing the men's abilities. Where possible, their ideas are incorporated in procedure, etc., since these give him a personal touch in the overall planning.

The aim of the entire program is to find the impending troubles before they become detrimental, and to correct them at our convenience.

As previously stated, the program has been gradually installed over the past several years. Additions will be made for some time to come to offset the more rigid requirements, and to utilize the newer tools and ideas as they present themselves.

Complete figures on mill delays and costs are kept. They indicate beyond doubt that the program has been successful to date. Mill delay times and maintenance costs have decreased materially.

Based on man hours worked, our mill delays resulting from mechanical and electrical breakdowns collectively, have decreased 44 per cent. Our cost per ton, in spite of advanced material and supply costs have decreased 25 per cent. All of which has aided to some extent in the breaking of 90 records—turn, week, month, and yearly production records, since the program was inaugurated.

DISCUSSION

PRESENTED BY

R. W. COUCH, Superintendent Mills and Shipping Yard, Bethlehem Steel Co., Saucon Division, Bethlehem, Pa.

H. F. JACQUART, Master Mechanic, Blooming Mills Department, Pittsburgh Works, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

W. P. KRONQUIST, Master Mechanic, Keystone Steel & Wire Co., Peoria, Ill.

Robert Couch: I would like to ask if in your crane inspections the same men who make the inspections also make the repairs? I believe you stated that crane men do all of the lubricating on cranes. Do those crane men report to the operating or to your maintenance personnel?

H. F. Jacquart: The crane men report to the electrical maintenance foreman. They receive their work instruction for the operation of the crane from the operations personnel. The care of the crane is vested solely in the electrical foreman, they report all delays, mishaps, etc., and are accountable to him for the greasing and oiling. I might add one other thing. In our plant we have recently gone into the centralized method of lubrication. We have had the first crane equipped for approximately one year, and it is absolutely perfect. We

propose to equip additional cranes in the near future.

W. P. Kronquist: Maybe at Keystone we have been somewhat old fashioned in lubrication of our blooming mill. Our oil man has been the inspector at the same time, and he has turned in his report. Within the last three or four months, we have studied centralized lubrication which we figure on getting into also. We have inspected both the single and dual lines of lubrication. The question that I would like to have answered, is which would be the best?

H. F. Jacquart: I will not make a statement as to which is the best, but let me say this, we are equipped a hundred per cent with the dual line system. We have roughly around ten large systems in the department and approximately twelve or fifteen hand centralized systems, all dual lined.

W. P. Kronquist: Why?

H. F. Jacquart: We had at one time tried one single line system that is no longer on the market for sale so I guess I may talk about that. At the time it was installed, we also installed our first dual line system. That system has been installed since 1936 and I would say that ninety per cent of the distributing valves on that system have never been changed to this day. The single line system continually gave us trouble on the distributing valves. Our men are educated along the dual line system and we felt that with the results we had experienced we would be foolish to try any other system.

Moreover it becomes a matter of spares. Those valves are interchangeable anywhere in the mill. If you have ten or fifteen different types of systems you would have to have ten or fifteen types of replacements. This way the same spare can be used on any piece of equipment we have. It keeps our inventory down materially.

W. P. Kronquist: In other words, when you look at the dual system you have around about two to four times as many places for leaks as you do on the single system. We inspected a single line system that had been in operation for nineteen years. We talked with the man that had been operating it for the biggest percentage of that time, and he would not have anything but a single line. Then when you go another place and inspect a dual line, the operator may say well, we have a leak here and a leak there once in a while.

H. F. Jacquart: We run complete welded lines, which we weld solid except in some places where we may have to have a piece of the main line taken out to facilitate a repair. Here we use regular weld flange couplings, we use no screw joints excepting from the main line to the valve. I do not know what happened to be the matter with that pipe-fitting job you spoke of but we do not encounter the difficulties you mentioned. Most of our difficulties are from the distributing valve on out to its destination, that is in the flexible hose part or whatever it may be, but inherently in the system we have no leakage problem at all.

W. P. Kronquist: I will say this, on the dual system I looked at there was very little welding.

H. F. Jacquart: We go with the welded construction all the way through. We find it gives us a much better job.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Monday, January 26, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Steel Mill Cranes," by R. J. Harry, Vice President, Alliance Machine Co., Alliance, Ohio.

Thomas Jefferson Hotel, Birmingham, Ala.

▲

BUFFALO SECTION

Tuesday, January 13, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

"Rolling Mill Yield," by Leo Silliman, Superintendent of Steel Conservation, Republic Steel Corp., Buffalo, N. Y.

Hotel Sheraton, 715 Delaware Ave., Buffalo, N. Y.

▲

CHICAGO SECTION

Tuesday, January 6, 1953 — Dinner 6:15 P.M., Meeting 7:45 P.M.

"Ingot Buggy Drives," by A. R. Oltrogge, General Electric Co., Schenectady, N. Y.

Phil Smidt's Restaurant, 1205 N. Calumet Ave., Hammond, Ind.

▲

DETROIT SECTION

Tuesday, January 13, 1953 — Dinner 6:30 P.M., Meeting 8:00 P.M.

Trip to Dearborn Engineering Laboratory, Ford Motor Co., Dearborn, Mich.

Dining Room, Dearborn Engineering Laboratory, Ford Motor Co., Dearborn, Mich.

▲

PHILADELPHIA SECTION

Saturday, January 3, 1953 — Dinner 6:00 P.M., Meeting 7:00 P.M.

"Use of Magnetic Amplifiers in Control Circuits," by Robert T. Lucas, Electrical Superintendent, Weirton Steel Co., Weirton, W. Va.

"6900-Volt Power System Fault Relay Analysis," by J. A. B. Pinney, Electrical Design Engineer, Alan Wood Steel Co., Conshohocken, Pa.

Engineers Club, 1317 Spruce St., Philadelphia, Pa.

▲

PITTSBURGH SECTION

Monday, January 12, 1953 — Dinner 7:00 P.M., Meeting 8:00 P.M.

"Plant Welding Application," by H. J. Ralston, Superintendent of Maintenance, West Mills, Homestead Works, United States Steel Corp., Munhall, Pa.

"High Speed Photography" — A Movie, "Magnifying Time", L. Sandell, Industrial Division, Eastman Kodak Co., Rochester, N. Y.

"Maintenance Experience on 600-Volt Rectifiers," by Robert T. Lucas, Electrical Superintendent, and H. K. Fish, Electrical Foreman, Strip Steel Department, Weirton Steel Co., Weirton, W. Va.

University Club, University Place, Pittsburgh, Pa.

SOME EXPERIENCE WITH AIR POLLUTION ABATEMENT IN THE STEEL INDUSTRY

By C. A. BISHOP
Research Associate
United States Steel Co.
Pittsburgh, Pa.

. . . . from a paper presented before Air Pollution and Smoke Prevention Association of America, Inc., June 10, 1952 . . . .

▲ WHEN one considers the size and the variety of the operations conducted in the larger steel plants, the magnitude and complexity of the job to be done in minimizing air pollution can be readily visualized.

Open hearths—The first approach was a study of dust loading throughout the various periods of melting and refining in the open hearth. The method used for sampling the dust loadings is a modified Brady method. This comprises filtering a metered volume of gas through a paper thimble. From the change in weight of the thimble for a given amount of gas, the dust loadings can be calculated.

Because it was found that the dust loadings vary appreciably during the course of the heat, a sampling program had to be developed that would properly represent the conditions. The heat was broken down into six periods: the melt down, hot metal addition, ore boil, lime boil, working heat, and empty furnace.

A large number of samples has been obtained for each period and for a number of different heats in order to find the average and maximum dust loadings. The work done to date has been carried out for the most part on oil-fired furnaces. The dust loadings vary widely, ranging from almost zero to peak loads as high as two gr per standard cu ft. The average dust loading is about 0.43 gr per standard cu ft. Figure 1 shows the average dust loadings during a heat in an oil-fired open hearth. Peak loads are obtained during the periods of hot metal addition, ore boil, the lime boil, and when working with oxygen.

A study of the particle size of the material collected has shown that approximately 50 per cent by weight of the dust from an oil-fired open hearth is smaller than five microms, with only a few per cent above 20 microns. Many particles smaller than one micron are present. The small size of these particles can be appreciated when we consider that the smallest individual particles visible to the naked eye are about ten microns in size; the minute particles in cigarette smoke are about 0.1 to 0.2 microns in size. Chemical analysis shows an iron oxide content of about 90 per cent.

During the melting of an open hearth heat, the color of the flue gases coming from the stack varies from white to reddish brown. One point of particular interest here is the lack of correlation between the color and the dust loadings, which precludes the development of a modified Ringelmann chart for the open hearth. However, the use of a photo-electric cell will be tried in an endeavor to develop a more convenient and less expensive method of sampling stack effluent.

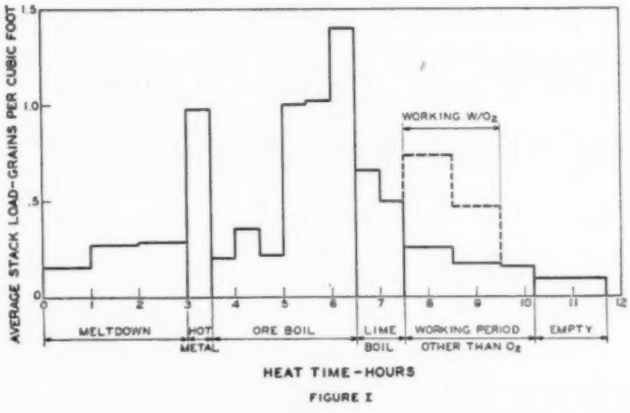


Figure 1 — Dust load varies appreciably in different stages of open hearth heat.

As soon as the study of open hearth dust loadings at the various open hearth shops with their different methods of operation was completed, an investigation of equipment to control the emissions was undertaken.

The fact that there is a large percentage of fume present in the stack gases from an oil-fired open hearth indicates that either an electrostatic precipitator or a high-energy requirement wet washer will be needed to reduce the solid content of the stack emission by more than 50 to 60 per cent.

Several types of equipment have been studied in connection with open hearth gas cleaning. However, the cost of installing and operating such equipment appears to be very high and may be prohibitive, particularly if the stack must be rendered visually clear, which re-

quires a reduction of 95 to 98 per cent in the stack emission. The early development of less expensive equipment to clean fumes from gas is a challenge to the gas cleaning industry.

It may be well to mention at this time other results which have been obtained on dust loadings from open hearths. Data of this kind obtained at open hearths in Los Angeles County, have been published which show loadings averaging 0.8 gr per standard cu ft. However, because of the nature of the scrap used and the fact that since there is no blast furnace operated in conjunction with the plants, all the metal charge enters the furnaces as scrap, and the nature of the dust is quite different from that found in Pittsburgh. Essentially, the dust found in the Los Angeles studies is a fume, the particles being mostly below one micron in size. The fume contains large amounts of zinc, with only a small amount of iron oxide present. The only industrial open-hearth gas cleaning installation now being used in this country is an electrostatic precipitator in Los Angeles County.

Published data on the open hearth stack loadings at the Donora plant of the American Steel and Wire Co. show a dust loading of 0.02 to 0.07 gr per standard cu ft, using natural gas as a fuel. Some preliminary data, which have been taken in the Pittsburgh district, have shown dust loadings of 0.10 to 0.40 gr per standard cu ft when natural and coke oven gas are used as fuels.

It has been shown that about 90 per cent by weight of the solids collected from the stack gases of a gas-fired open hearth are smaller than five microns. This size distribution means a difficult cleaning problem. Because of the small particle size, the stack gases appear dirty, even though the fume is present in small amounts. This then is another case wherein it must be decided whether the standard for cleanliness is to be measured in concentration of solids or is to be a visual inspection of the color of the stack gases.

The recent practice of using oxygen applied directly to the bath during the working period of the heat to accelerate the refining process may add a complication. There is a reference in the literature to the use of a Venturi scrubber for removing the dust under these conditions. It is reported that the mean diameter of the particles is in the range of 0.25 to 0.33 microns with many particles down in the 0.05 to 0.10 micron range. Efficiencies of 97 to 99.7 per cent, on a weight basis, were reported, but the power requirements and maintenance costs are reported to be extraordinarily high.

Bessemer converter—There does not appear to be a ready answer to this problem. A major difficulty lies in the design of a suitable arrangement to confine the gases for treatment. Once the gases have been confined, the dust loadings and the characteristics of the solids will be measured.

Blast furnace slips—The cleaning of blast furnace gas has long been a well established art, and today more than 7,000,000 standard cfm are being cleaned in the blast furnaces in this country. However, the control of slips or irregular movements of the furnace burden does require study. Extensive studies in the past have not led to a solution of this problem, but there is some indication that further instrumentation of the furnace may help to decrease the number of slips that open the safety valve. As the raw materials going into the blast furnace are improved, the tendency to slip decreases. Therefore, the huge sums being spent for sintering and coal preparation plants are being helpful in this problem.

Ferromanganese blast furnace gas cleaning — Another problem occurs in the case of blast furnaces producing ferromanganese. In the operation of these furnaces, a large quantity of dense fume may be vented to the atmosphere. The amount and types of particles which make up this fume are much different from those commonly found in the gases from blast furnaces producing basic pig iron. For these reasons, the gas cleaning equipment acceptable for use in each of these two cases is greatly different.

The dust found in ferromanganese blast furnace gas is of two types. One type, comprising about 20 per cent of the dust present, consists of particles above 20 microns in size which, from their analysis, appear to originate in the disintegration of the coke and ferromanganese grade ore in the furnace burden. This fraction of the dust is removed from the gas stream by a conventional dust catcher. The other type, which accounts for 80 per cent of the solids present in the gas as it leaves the furnace, is a typical fume, with particle sizes varying from 0.10 to 1.0 micron. This material is apparently formed by a process of vaporization and condensation, which explains its extremely small size. It is the presence of this material which renders the problem of cleaning ferromanganese blast furnace gas so vastly different from the cleaning of basic blast furnace gas.

The work to be described deals with the project which was undertaken by the United States Steel Co. to develop a practical method for removing and disposing of the fume described above.

The first step in the program was to define the problem precisely in terms of fume loadings, fume composition, gas flow, gas composition, and temperature, and to obtain several hundred pounds of the fume so that a process for disposal of the material could be developed and tested by laboratory methods. The collection of the large sample of fume required for preliminary testing was accomplished through the use of a linen bag filter. While this collection method was useful in obtaining samples, the method was not practical for a commercial installation on ferromanganese blast furnace gas.

It was found that the fume loadings averaged about 7.5 gr per standard cu ft. The manganese content of the fume varied from 15 to 25 per cent. The unusually high alkali content, which was found to vary from 8 to 15 per cent, apparently results from concentration of the alkali originally present in the manganese ore. Presumably, this takes place in the process of vaporization and condensation previously mentioned, so that the alkalies become an intimate part of the fume particles.

From the standpoint of recovering the manganese from the collected fume by returning it to the blast furnace, the high alkali content is a major consideration, because of its possible damaging effect on the furnace refractory lining. Accordingly, it was necessary to develop some treatment which would substantially reduce the alkali content of the collected fume.

The fume as collected is grey and extremely fluffy.

The particle diameters were found to range from 0.1 to about 1.0 microns, the average being approximately 0.3 microns. Such fine particles present a problem in processing and in any other handling required for further treatment after collection.

The fume was also found to be pyrophoric, that is, if heated to approximately 350 F and exposed to air, it begins to oxidize, with the liberation of considerable heat, slowly turning from a grey to brown color as the oxidation proceeds. During this color change, the manganese oxides originally present are further oxidized and the carbonates present are decomposed. This burning operation also increases the density of the fume and renders it less floury.

With the measurements mentioned above completed and an adequate supply of fume for experimental use, the development of a suitable process was undertaken.

There appeared to be only three types of equipment which might be considered for the commercial installation; namely a high-energy requirement wet washer, a sonic coagulator, and an electrical precipitator.

Although wet washers are used in cleaning ferromanganese gas, it is reported that high maintenance costs attend such an operation because of the cementing properties of the fume. More important, the use of any wet washing method would require the design and installation of a large scale water treating plant in order to satisfy existing stream pollution regulations. With these complications in mind, it was thought advisable to consider other means of dust collection.

Some preliminary testing work was done on the use of a sonic coagulator for agglomerating the ferromanganese fume. The results of this work indicated that the sonic unit, which was constructed from a horn-type speaker excited by a variable frequency oscillator and power amplifier, would agglomerate the fume if the retention time of the gas in the sound chamber was well over three seconds at a sound pressure intensity above 160 decibels. Based on an economic evaluation of this factor, it was concluded that the sonic process, in its present state of development, was not attractive, and the urgency of solving the problem was such that it was not considered desirable to undertake the further development of this method.

Our company had had some previous experience with a ferromanganese gas cleaning plant which included a unit for the dry electrostatic precipitation of ferromanganese fume. The collection efficiency of the precipitators had been found to be satisfactorily high, although difficulties with companion equipment for conditioning the gas and for handling and disposing of the collected dust had forced the abandonment of the cleaning plant at that time. It appeared possible to redesign the gas conditioning sections of the plant and to develop a more positive method of fume disposal.

In the final plan, therefore, it was proposed to cool and condition the gas simultaneously by passing it through a spray tower of sufficient capacity to cool the gas from an average temperature of 700 to 350 F by evaporation of water in the tower. The spray tower, which was to operate without any water effluent, would cool and humidify the gas, as had been shown in the previous work to be necessary to maintain smooth and efficient operation of an electrical precipitator. This method of gas conditioning, therefore, was adapted for inclusion in the pilot plant.

The second step was to develop possible methods of handling and treating the collected dust. It soon appeared desirable to take advantage of the pyrophoric character of the material, since such a treatment increased the apparent density of the fume from about 12 lb per cu ft to about 30 lb per cu ft and rendered it less "dusty." It was also found that the burned fume was more easily wetted and could be formed into briquettes which did not disintegrate in water.

Since the fume was to be removed continuously from the precipitator, equipment had to be provided for continuously burning the fume with a minimum of loss by dusting. Because the burning reaction is exothermic, and hence, self-sustaining in the presence of air, only a small amount of external heating was required to make up for heat losses. A kiln was adapted for use in the final pilot plant.

It was considered necessary that the fume be briquetted or otherwise agglomerated, before it could be safely stored in any open area where prevailing winds might otherwise create an air pollution problem. Experimental work indicated that water could be added to the burned fume and this mixture briquetted. The addition of portland cement did not appear to increase the strength of the final briquettes.

As mentioned previously, these briquettes have a high alkali content, which makes them undesirable for use in the blast furnace. For this reason, an alternate process was investigated. This process was based on the fact that when the burned dust is leached with water, roughly one-half of the alkalies are dissolved. Tests showed that varying the leaching temperature from 70 to 212 F and increasing the retention time in the leach water beyond five minutes did not appreciably affect the percentage of alkali removed. The alkalies which are not removed by leaching are probably held as complex metal salts.

Of necessity, the leaching operation had to be followed by filtration in order to recover the solids from the slurry. Filtration tests showed that the filter cake would contain from 55 to 60 per cent moisture. It carried this high moisture content because of the small size of the particles involved. Because such a filter cake, as discharged from the filter, is too wet for briquetting, it was necessary to dry it before further processing. An outside-fired rotary drier was chosen for the drying operation. As in the case of the unleached dust, all that was found necessary for the production of sound briquettes from the leached dust was the addition of a small quantity of water just prior to the briquetting operation.

The pilot plant, Figure 2, was designed to clean 3000 standard cfm of dry ferromanganese blast furnace gas in order to obtain sufficient clean fuel to fire one of the boilers in the plant. This represents about one-fifteenth of the gas produced by one blast furnace. Such an arrangement permitted a study to be made of the advantages to be gained at the boiler, made possible a visual guide as to the degree of gas cleaning attained, and provided approximately 190 lb per hr of fume for further experimental processing. The pilot plant was fully instrumented to permit the collection of sufficient

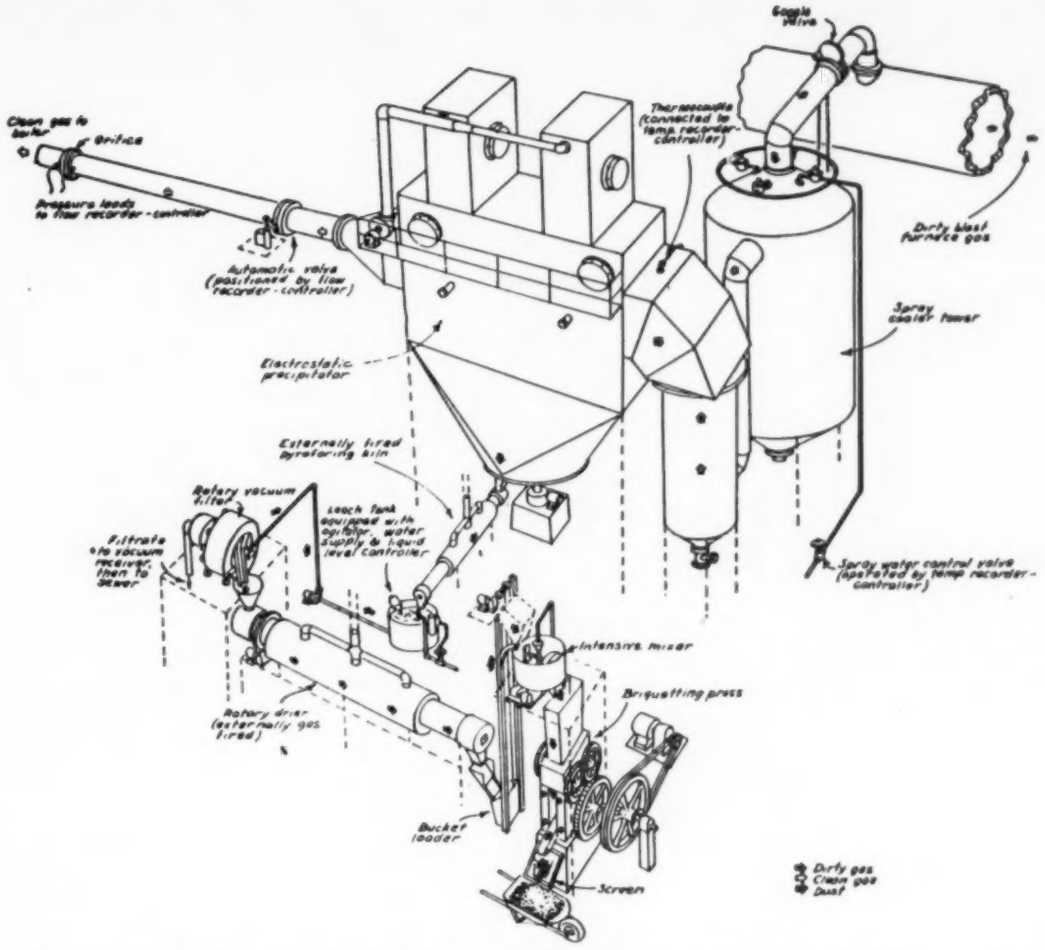


Figure 2 — Schematic sketch shows design of pilot plant for cleaning ferromanganese blast furnace gas.

data for design calculations for the contemplated full-scale installation.

The dirty gas to be treated first entered the spray cooler of the electrostatic precipitator, where it was cooled to about 350 F. It was essential that all spray water be evaporated in this unit since any bottom drip would cause the fume to form a hard-setting cement.

When the sprays were properly maintained there was no discernible drip from the bottom of the tower and no wet fume accumulation within the tower. However, it was found that approximately 10 per cent of the fume in the gas was removed from the tower hopper as dry material. In the full scale installation a screw conveyor will be provided to remove this material continuously and transfer it to the pyrophoring kiln.

Conditioning the gas with ammonia rather than water was tried without success. Satisfactory conditioning was accomplished by the use of steam, but the cost of such an operation on a full scale plant would be prohibitive.

A plate type precipitator was installed in the pilot plant with a guaranteed removal of 98 per cent of the fume. The cleaning chamber of the precipitator was 6 ft wide, 10.5 ft high and 14 ft long and contained two banks of cleaning electrodes which were operated at 65,000 volts. A rapper located in each insulator compartment gave the discharge electrodes a single blow every four or five seconds and the collecting electrodes were vibrated continuously by an air actuated mechanism. Although a number of difficulties were encountered in the operation of the spray cooler and precipitator during the first few months of operation of the pilot plant, various modifications of these units ultimately resulted in very satisfactory operation of the collection equipment as a whole.

A rotary plow and rotary star valve were included in the precipitator hopper to remove the collected fume from the precipitator.

The use of a rotary kiln 10 in. in diam and 10 ft long for performing the burning operation in the pilot plant proved very successful. The fume was discharged from the precipitator at about 350 F. It fell down a vertical chute onto a 4-in. rotary feeder paddle which kept the material moving into the kiln. It was found necessary to install this paddle wheel arrangement at the kiln inlet to prevent plugging at that point. In order to prevent the dust from building up on the kiln wall, it was found necessary to position the scraper near the top of the kiln.

Gas burners installed under the kiln provided the heat required to start the dust burning, following which the gas could be turned off since the heat supplied by the oxidation of the fume was sufficient to maintain the reaction. This oxidation required about one-half cu ft of air per lb of dust processed. As a result of this oxidation step, the fume is changed from a reducing to a strongly oxidizing material. Although the material was not completely oxidized as it left the kiln, the reaction had proceeded sufficiently to impart the desired changes in the physical properties of the fume.

The dust discharged from the kiln was either prepared for briquetting or leached prior to briquetting. For the first case the dust was discharged directly to a 3-ft diam intensive mixer, modified to minimize the discharge of steam and fume which would otherwise take place when the hot fume (400-500 F) entering the mixer came in contact with the water required for briquetting. It was not considered feasible to attempt to pre-cool the fume prior to mixing because it is still burning as it discharges from the kiln. Instead, the mixer was enclosed by a water-cooled hood and otherwise modified to receive the hot fume and water continuously and to discharge the mixture continuously. The hooded condenser was continuously scraped to prevent fume buildup on its inner cooling surface.

Briquetting was carried out using press rolls which developed an estimated pressure well over two tons per sq in. The rolls were driven at one rpm to produce 74 small almond-shaped briquettes per min. The rolls discharged the briquettes onto a 6-in. wide belt conveyor, which discharged the briquettes to storage.

To test the leaching of the dust prior to briquetting, the leaching operation, accompanied by the necessary following steps of filtration and drying of the filter cake, is introduced after the fume-burning operation and before the mulling operation, if it is desirable to reduce the alkali content of the fume in order to condition it for use in the blast furnace.

To recover the solids from the leach slurry, it was pumped to an 18-sq ft rotary vacuum filter. The filtrate was relatively clear, with a pH of 13.5 and contained less than 0.5 per cent solids. The filter cloth was kept clean by a reverse steam blow.

An externally fired rotary kiln dryer was found to dry the filter cake satisfactorily from 55 per cent to less than one per cent moisture.

The visible effect of gas cleaning on the boiler stack effluent was impressive. The stack of the boiler in which the cleaned gas was burned did not emit a discernible fume, while the others did. Although the loading of the cleaned gas entering the one boiler was about 0.12 gr per standard cu ft, the stack effluent loadings were only about 0.05 gr per standard cu ft because of the dilution of the gas with the air used for combustion. The cleaned gas burned with a short, bright blue flame.

Emphasis was placed on the operation of the spray tower, precipitator and pyrophoring kiln because their functioning comprised the more difficult phase of the process. Operation of the remainder of the plant was intermittent, but of sufficient duration to test the units adequately and to obtain the necessary operation data.

As a result of this work, a plant has been designed to clean 135,000 standard cu ft of ferromanganese blast furnace gas per min.

SUMMARY

This paper has discussed the experiences that the steel industry in Allegheny County, Pennsylvania have had in attempting to solve the several air pollution abatement problems of particular concern to the steel industry.

BIBLIOGRAPHY

1. *"Cleaning Ferromanganese Blast Furnace Gas,"* by C. A. Bishop, A. H. Brisse, R. G. Thompson, C. R. Liebel, *and* W. A. Swaney, American Iron and Steel Institute 1951 Yearbook.

2. *"Sonic Agglomeration of Fume in Ferromanganese Blast Furnace Gas,"* by A. H. Brisse, Industrial Heating, November, 1950.

MINES BUREAU REPORTS ON COKING COAL RESERVES

▲ KNOWN reserves of coking coal in beds more than 28 in. thick in Knott County, Ky., are estimated at 1,174,072,000 tons, but only a little more than half this amount—623,742,000 tons—is considered minable on the basis of present recovery rates in underground coal mines of that section.

In addition, the known measured and indicated reserves of coking coals in the thinner beds—from 14 to 28 in.—totals another 684,908,000 tons. This is not "minable" because 28 in. is about the minimum thickness of coal now being mined by hand loading onto conveyors in Knott County and the northern Appalachian region.

Results of the Bureau's survey of coking coal in Knott County as of January 1, 1950, are incorporated in a report made public by John J. Forbes, Bureau Director. All known reserves in the Kentucky county are under less than 2,000 ft of overburden, according to the report. Investigation showed that there are three beds of major importance so far as present production and reserves are concerned. They are the Upper Elkhorn No. 3, Fire Clay, and Flag. There are also three beds of less importance, Upper Elkhorn No. 1, Upper Elkhorn No. 2, and the Hindman, and two that are presently of minor importance. The Upper Elkhorn No. 3 bed contains the largest known reserve, 449,417,000 short tons in beds 28 in. and more thick, of which an estimated 248,660,000 tons are recoverable.

The weighted average percentage of recovery for all beds in Knott County, including all mining losses, is 53.13. The highest single percentage is 59.2 for the Hindman bed, and the lowest is 51.4 per cent for the Fire Clay bed. Because Knott County coals are low in ash and sulfur, they are chemically well-suited for coke making. However, as they are high-volatile A bituminous coals, they should be blended with low- and medium-volatile coals to obtain coke of good metallurgical grade.

Besides tabulating estimated reserves by Geological Survey quadrangles for the Hindman, Flag, Fire Clay, Whitesburg, Amburgy, Upper Elkhorn No. 3, Upper Elkhorn No. 2 and Upper Elkhorn No. 1 coal beds, the Bureau's report includes maps of each bed. These show the area and location of known reserves in beds more than 28 in. thick, known reserves less than 28 in. thick, mined-out areas, areas which, although excluded from the estimate, may contain reserves based on geologic inference, and areas outside the outcrop. The report also contains brief descriptions of the chemical properties and carbonizing characteristics of the coals.

Report of Investigations 4897, "Estimate of Known Recoverable Reserves of Coking Coal in Knott County, Ky.," was written by James J. Dowd, senior mining engineer, the late Albert L. Toenges, former principal coal mining engineer, and R. F. Abernethy and D. A. Reynolds, chemists, all of the Central Experiment Station, Bureau of Mines, Pittsburgh, Pa. A free copy of this publication may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh 13, Pa.

By S. L. FLUGGE, Research Dept., Continental Can Co., Inc., Chicago, Ill.

PLATE QUALITIES REQUIRED IN CAN MANUFACTURING

. . . . future developments in sterilization methods may allow lighter weight tin plate stock to be used . . . .

▲ THE word "quality" is becoming more and more evident in industry. Special attention is being given to maintaining production at the optimum economic quality level. Such special attention is well warranted because, the buyer, the customer, or consumer is becoming increasingly quality conscious. Obviously, he wants the most he can get for his money and the most means quality as well as quantity. Cans of high quality mean a decrease in the canner's risk of loss. During periods when supply fails to meet the demand, quality levels tend to be lowered because of the added emphasis on quantity, but when the supply is ample the emphasis again is definitely on quality. A competitive, dynamic and expanding industry must create new demands to take care of ever increasing production.

There is no question but that the can making and canning industries have expanded rapidly in the past several years and there are definite indications that this expansion will continue. One of the best ways to keep an industry strong and growing is by providing products of high quality to meet adequately the customer's or consumer's requirements. In order for the canmakers to produce consistently high quality cans, it is necessary that they use high quality materials.

Quality requirements are defined by specifications. Therefore, along with the increased interest in quality there must be an increased interest in specifications. Similarly, of necessity, there has been an increased interest in the measurement of quality as evidenced by the development and use of quality control systems and procedures.

Determining what the ultimate consumer really wants in regard to the quality of cans is not as easy as it may sound because he is a composite of a great many individuals. Furthermore, his desires may have to be tempered by certain factors concerned with the canning or packaging operations. Still further tempering may be required because of certain limitations in the present art of can making. The close relationship between the canmakers and the canners makes it possible to bring these requirements in practical terms to the attention of the suppliers of plate.

Cost is always a very important factor and accordingly there always exists the necessity for good judgment in using plate of minimum base weight which will still meet minimum strength requirements. However, in arriving at a specification for a nominal plate weight, the consequence of failure and its cost must be taken into consideration. For example, in determining the nominal base weight to be used for a can end, the actual weight of the lightest sheets must be determined. The base weight and temper characteristics required of plate will depend upon the purpose for which the can is made. Cans for products which generate considerable pressure during pasteurization, sterilization or storage, which include such products as beer, vegetables and aerosols, must have ends sufficiently resistant to internal pressure to prevent permanent outward distortion (buckling) of ends. Cans which are under high internal vacuum such as vacuum packed products or those sealed at high temperatures must have body plate sufficiently resistant to prevent partial collapse (paneling) of the bodies. Larger size cans must be made of heavier or stronger plate than smaller size cans to minimize damage during handling and shipping.

The maximum variation from sheet to sheet as given in the AISI Steel Mill Products Manual, Tin Mill Products, Section 14 is plus or minus 10 per cent from the nominal. Thus, in evaluating a nominal 100-lb plate it is not adequate to test only sheets that are actually of 100-lb base weight; some sheets of 90-lb actual base weight may be expected and these must be tested to determine the lower normal limit. Actually in practice, a few lower base weights are also evaluated, because it it desirable to have the additional information, and because occasionally such lower weight plate might be found within a given lot. One must realize too that the plus or minus 10 per cent variation is on a sheet basis which averages the variations that exist on the individual sheet.

Weight determinations on thousands of individual 4-sq in. samples have furnished data for distribution curves which indicate what weight variation may be expected on this smaller area basis and the final plate weight specification for a given series of products take these data into consideration. Buckled ends are expensive; not only is the cost of the container lost, but part if not all of the cost of the material packed into the can is lost too. Accordingly, plate weight specifications for ends are established to provide sufficient strength so that no ends will buckle under normal canning conditions. It is obvious that if the one or two per cent of plate represented on the lower end of the distribution curve could be eliminated, the nominal base weight could be reduced significantly.

When buckling occurs or has occurred in a cannery, technical service men representing the manufacturer of the cans involved are usually called upon to determine the cause of failure. Samples of cans showing failure as well as control samples showing no failure are sent to the laboratory for examination and the canner's operating practices are also examined to determine whether

some faulty operation may or may not have been responsible. Base weight and temper and sometimes chemical analyses are made on the sample sent to the laboratory. Sometimes there is no significant difference between the data on ends that buckled and those that did not, and if the values fall within what has been established as "normal" for the plate, the cause of failure is attributed to some other factor. However, more often the base weight, temper and/or chemistry of the buckled end differ considerably from the controls, and those values established as normal for the specified plate, and therefore the cause of failure must then be attributed to the plate. Often the number of failures corresponds to the number of ends that can be made from a few sheets of plate, and this would indicate the possibility of a few sheets from some other lot of plate having been included in the lot being used.

These may sound like minor difficulties but they may be very expensive. The material loss usually is only a small part of the total cost. The time required to investigate the complaint, and to make the laboratory analyses are expensive. In addition to these direct monetary losses there is always the intangible loss of good will that may occur as a result of complaints.

What has been said of buckling of ends holds equally as well for other types of failure, such as other deficiencies in mechanical strength and deficiencies in resistance to atmospheric or product corrosion. These are the types of failure associated with plate with which the canner is acquainted. New uses for cans have resulted in new and more stringent demands on materials, and the success or failure of a venture in a new field depends largely upon satisfactory materials. Accordingly, since the canmaker can determine the material requirements, such as plate specifications and tolerances, with which he can operate satisfactorily, the problem is to determine if and how consistently the manufacturer of the plate can produce such plate. If plate can be and is produced consistently within the specified limits, one of the biggest requirements will be achieved.

More specifically, the difficulties attributable directly or indirectly to plate which are encountered most frequently by canners may be summarized as follows:

1. Excessive buckling and paneling resulting from the use of plate of low base weight and temper for containers subjected to processing.
2. Leakage resulting from pinholes which are not detected before filling.
3. Excessive rusting or corrosion resulting from inadequate tin coating or incorrect plate chemistry.
4. Variations in appearance of lithography resulting from variation in reflectivity of plate.
5. Enamel failure occurring after processing as a result of poor surface conditions such as excessive oxide, oil or dirt.
6. Leakage or other can failures resulting from defective manufacture which in turn was a result of using plate inferior in solderability, drawing characteristics or otherwise "off specification."

It is impossible to detect economically every inferior can that is made during commercial operations. The cost of inspection, including sampling and testing, would be prohibitive to give complete 100 per cent assurance of perfection. The preferred means of approaching that goal is to put the effort into using optimum quality materials and equipment, and best known operating practices. The equipment and operating practices in can making are problems of the can maker but the materials used are of mutual concern to the supplier and the can maker.

One of the principles of quality control, that of testing and controlling as close as possible to the actual operation, is being given more and more consideration, and as a result the users will be depending more and more on the supplier's tests rather than sampling and testing at the point of use. To accomplish such a procedure, a thorough mutual understanding of the problems involved as well as the specifications to be maintained is necessary. Although it may be said that there is always room for improvement, it would appear that at the very least this mutual understanding between the steel maker and the can maker already is well established.

A properly functioning quality control program assists in keeping quality within control limits, but the best opportunity for improving the quality of plate as delivered to the can maker is through improvements in the process rather than by bigger and better inspection procedures. This is well demonstrated by recent developments in plate manufacture. It is only necessary to mention the strip mill, cold reduction, electroplating of tin and continuous annealing to recall the significant improvements these processes brought about in quality, particularly in regard to the uniformity of plate. Increasing the uniformity of plate, or in other words decreasing the variation or range, without increasing cost will not only make it possible to make better cans, but also to make them at a lower cost.

The plate qualities required for can manufacture in the future will be affected by government regulations as well as economic considerations. Tin conservation appears to be necessary for some time and even more drastic restrictions may be expected if a more serious war develops. For this reason dual or differentially coated plate probably will be used more extensively.

An important quality of differentially coated plate is the means used to identify the two different sides. The means of identification must be conspicuous and readily observable by the operators in the can plant, because it is obviously important not to have the plate reversed, particularly with the grades having a maximum difference between the two sides, such as 100/25 plate. The identification should be of such a nature that each can body or can end will carry the identification. Although the identifying means should be conspicuous, it preferably should be of a pleasing nature or at least it should not be too distracting or change the appearance of the finished container radically.

When the subject of identification was first discussed it seemed that most everyone had a slightly different concept of what should be used. It now appears that the field has narrowed down to two systems: one depending upon the difference in reflectivity which results from putting a "satin" finish on one side and a smooth or bright finish on the other side of the steel before plating with tin, and the other depending upon a mark applied to the tin after plating but before fusing. Considerably more information regarding the relative merits of each method should be available at the end of this year.

Another subject about which there is considerable uncertainty is chemically treated steel (CTS) plate.

The CTS plate used during World War II for ends gave very good results for the products for which it was used. However, it required an enamel on both sides and could not compete with electrotin plate with the lighter tin coating weights. In recent years, several new chemical treatments have been developed and evaluated to various extents. It appears that as long as there are adequate quantities of tin for electrotin plate of the lighter tin coating weights, there will be little incentive for the installation of the expensive equipment required to produce CTS plate commercially. In fact, plate with a 0.1-lb coating of tin may be used wherever CTS plate could be used. It is possible that even lighter tin coatings might be used to produce a plate equivalent to CTS, and in fact these lighter tin coatings might be considered in the same manner as chemical treatments, for although they do not supply adequate protection by themselves they are effective when used in conjunction with a suitable organic protective coating.

Since steel plate without a tin coating or a protective film produced by a chemical treatment is not satisfactory for processed foods with the enamels now in use, the question may be asked if it is not possible to develop organic protective coatings which are suitable for such purposes. Enameled steel cans have been made for processed fruits and vegetables in Germany. These cans had somewhat limited shelf life and were quite expensive because of the multiple coats of enamel and the spraying equipment required and therefore could not compete with cans made from plain or enameled tin plate. Steady progress is being made in the organic protective field, and it is possible that an enamel or combination of enamels may be developed that will be satisfactory for steel cans for processed foods. With the continued uncertainty of the tin available for can making and the probable high cost of chemically treated steel, there is a definite need for such an enamel system or some other satisfactory substitute or replacement for tin.

Future developments that may affect the plate used in can making are the possible use of methods of sterilization by radiation and the extended use of aseptic canning methods. When it is no longer necessary to make a small boiler out of each can, much lighter weight plate may be used. Of course, for products under high pressure or high vacuum, presently used base weights undoubtedly will not change to any great extent, but for other products a definite reduction in the base weight of steel probably will be necessary in order for it to compete successfully with other materials which might be used. Drastic reductions in base weights or thickness would impose many new problems not only for the manufacturer of steel but for the manufacturer of cans as well. The ability of an industry to survive depends upon its ability to change with changes in demands. We have good reason to believe that our industries will be able to meet successfully the changes in requirements that the future may bring.

DISCUSSION

PRESENTED BY

EMIL KERN, Vice President in Charge of Engineering, Allegheny Ludlum Steel Corp., Brackenridge, Pa.

A. R. GEISZLER, Application Engineer, Wean Engineering Co., Inc., Warren, Ohio

S. L. FLUGGE, Research Department, Continental Can Co., Inc., Chicago, Ill.

H. M. BRIGHTMAN, Columbia Steel & Shafting Co., Carnegie, Pa.

L. YLVISAKER, General Manager, Northeastern District, Continental Can Co., Inc., New York, N. Y.

Emil Kern: To what extent have you explored the application of aluminum, or perhaps stainless in making cans? You told us before that you use sometimes four different kinds of coating on steel to make a suitable can. Now all that can be expressed in dollars and cents.

S. L. Flugge: It can. One of my former bosses in talking to some of the metallurgists that came in to see us, said, "You started out with some steel, and that was not good enough, and then you put on some tin, and that was not good enough either, and finally we put on an enamel." In some cases, particularly for beer cans we have to put on two coats, and sometimes three. As you know, all of those operations are expensive and costly. If we could dispense with some of them it should reduce the price.

We have conducted many experiments with other materials, including aluminum. On stainless, some 20 years ago we made a dozen cans. The results were good with those cans that we were able to make. There were soldering difficulties; in fact, we could not solder at all, we made drawn cans.

There are other possibilities, possibilities of other coatings as well as tin. Again results remain to be seen. I think there will be considerable competition from paper for some products, particularly if aseptic methods of sterilization or aseptic canning procedures are used, or if some radioactive type of material is used. By these methods, high pressure is not developed during processing; in fact there may be no processing in the way we think of it at the present time. We have been given more and more assurances that very definitely there will be rather extended uses of radiation as a means of sterilization in the future.

Aluminum has its advantages; it also has its disadvantages. We run into a lot of disadvantages because our can lines were set for tinplate. One of the first things we noticed was an appreciable difference in the coefficient of friction and we had innumerable jams. That is a minor detail that undoubtedly could be handled. There is also the variation in weight and we had to use thicker plate to get comparable strength. For many purposes, aluminum is not satisfactory without a protective coating too. As you know, it's alkaline resistance is poor and its acid resistance is not too good either when it is used in the form of a container.

A. R. Geiszler: I would like to ask what is the possibility of decreasing production costs in switching from the use of sheets to continuous coils. That is, disregarding the present investment in machinery, would there be any reduction in their production costs by going to continuous coils?

S. L. Flugge: I can give you a partial answer. I know that our company is investigating this possibility at the

present time and there are several factors to be considered. From an over-all standpoint it would seem that there should be a very definite saving, and there is a definite saving, from several experiments, as far as frame scrap loss is concerned. There are of course very many complicating factors. With end stock the possibility is fair. With body stock, where irregular enamel margins are required, we are still far from working out a satisfactory means of registration. Enamels are made and are used for coating of, let us say venetian blinds and other materials, but the requirements for containers are much more severe. We have to have a very high bake, there must be a freedom from odors and flavors, and the bakes are now of several minutes' duration. We are working in conjunction with the various suppliers of protective coatings to develop very rapid curing materials of the synthetic type.

If you had a coil and you want to enamel it, we could not possibly use our present coatings. You saw the ovens that we had at the plant. The sheets are stacked upright and are over two feet tall. If you had that in coil form you can imagine how long that oven would be. It would be quite a job to support the plate. It takes us two minutes to bring it up to temperature, and it takes us about that long or a little longer to cool it. There would be another big job of cooling the plate. We can, or rather we could, heat it very rapidly by induction heating, and enamels have been developed to stand up under that particularly fast heating. There are still very many problems to be worked out. It is definitely a good field. I know our company, and I think several others, are investigating the economic factors.

A. R. Geiszler: Mr. Flugge mentioned something about the degree of reflectivity of the various tinplate. I wonder what their experience has indicated as to the uniformity of the reflectivity of tinplate from a line using induction reflow versus a line using conduction reflow. If any trend has been observed, which of the two processes yields the better product?

S. L. Flugge: We do not have that worked out statistically. I think we have had complaints from our plants regarding variation of reflectivity of plate from all of the mills. This is particularly noticeable in some of our beer can accounts. As I mentioned, some of the lithograph designs have what we call open design where the tinplate shows through. And in other places there are relatively light coatings applied and we get a certain degree of brightness by the reflection from the tin underneath. I think all of you know that No. 25 tinplate does vary considerably on reflectivity, and I believe that almost all of the mills experience that difficulty. At least they all have sent us good sized samples of it.

H. M. Brightman: It seems to me Continental Can Co. has gone a long way toward perfection of processing, in mass production of cans in every way. It appears it is up to the steel manufacturer to give them a base material to do the job. I wonder if it would be possible, with the type of sendzimir mill which I saw in operation in this country, to give greater uniformity of surface; perhaps they could control the reflectivity of surface better with the small roll than they could on a tempering mill with a larger roll?

S. L. Flugge: I am not a steelmaker and I do not know whether we could or not. Still I know that we, and I know our customers, would appreciate it if we did not run into variation of reflectivity. Obviously if you had a more uniform base there would be over-all greater uniformity of the finished tinplate.

However, I know in some cases, we have found the variation in reflectivity was a factor of the tin surface itself, in either deposition or fusing.

Incidentally, we do not expect the steel mills to just solve all of our problems. Actually we are trying to eliminate the open designs as much as possible where the customer is supercritical, to see if we cannot get an over-all design that is less subject to plate reflectivity. We realize that there are certain limitations in the manufacture of plate. We realize too that if we have a great improvement in quality which is dependent on close inspection, we are not going to be able to afford it. We feel some of these improvements are going to have to come about by significant changes in process rather than in inspection procedures. However, I think some of the lack of uniformity might be improved by improved quality control means or better manufacturing and operating processes.

We are learning how to make cans somewhat better. We have to produce them at a higher rate of speed, and every time we step up another ten or twenty cans per minute we run into about ten or twenty new problems.

Emil Kern: Speaking of so many cans a minute, I was told that one of the machines produced about 400 cans a minute and I was wondering how the inspection problem is taken care of to suit customer requirements. Particularly I wondered whether the requirements of our Armed Forces are any different than those of private industry?

L. Ylvisaker: To answer the last question first, we do not find that the quality required by the Armed Forces is as high perhaps as some of our beer customers, for instance. Beer cans particularly are one of the most delicate cans we make.

As far as our inspection procedures are concerned, we do it on a quality charting basis. We inspect for each one of our variables as indicated, and plot that, from 15 minutes up to an hour. And if they meet that the cans are satisfactory.

Member: I would like to ask a question about the rolls in the soldering process. What iron do you find best for the rolls in soldering?

S. L. Flugge: We find that in general if we have a steel or iron, that tins well and stays tinned well, it is just as good as anything you might have in the way of highly corrosion resistant steels. We made some experiments with various highly resistant alloys and although there was a considerable difference in their resistance to the zinc chloride—zinc ammonium chloride which is used as a flux in the solder pot; a good coating of tin minimizes differences in corrosion resistance.

We have found that 1020 steel worked out very nicely. However, a nickel steel seems to be just slightly better, again because the nickel steel tinned a little bit better than the other. In other words, as long as you have a good tinned surface, the tin is sufficiently resistant and it will stand up very well.

I think another factor too is that the nickel steel is a little harder and does not abrade as readily. On some of the cans, on beer cans particularly, it is necessary to obtain an inside fillet, and considerable roll pressure is required. However, the main thing is to get a steel that tins very well and stays tinned.

D-C MILL MOTOR BRAKE STANDARD

AISE STANDARD NO. 12

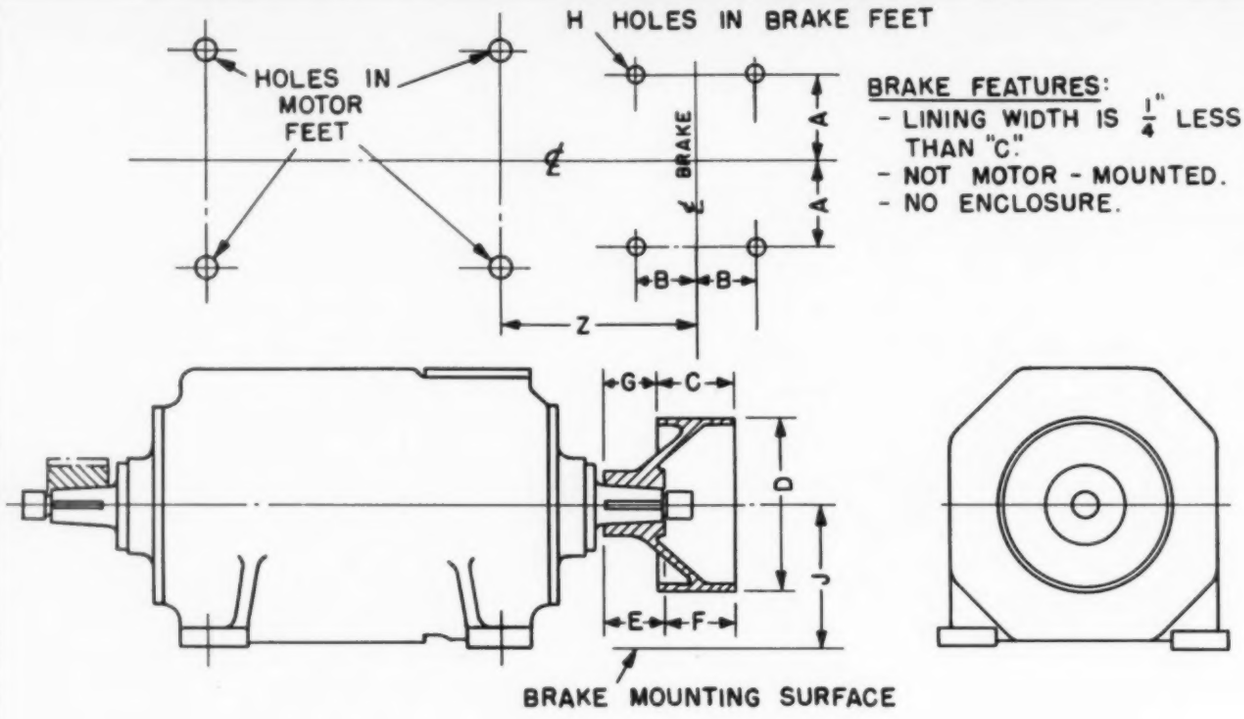
(TENTATIVE)

SEPTEMBER, 1952

PUBLISHED BY
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

1. General
   a. The development of the AISE 600 series mill motor, which is covered by AISE Standard No. 1, made desirable revisions in the design of the brakes used for such motors.
   b. The objective was to standardize d-c mill motor brakes for AISE 600 series motors so that all manufacturers brakes would be interchangeable with respect to mounting dimensions, torque rating and wheel dimensions.
   c. This d-c mill motor brake standard was developed by a combined AISE-NEMA group and will be a NEMA standard upon approval by the necessary NEMA groups.
   d. All brakes must be designed so that they can be applied to the AISE Standard d-c mill motors in such a way that the height from the center line of the wheel to the base of the brake shall be at least ⅛ in. less than the height from the center line of the shaft to the base of the motor. Thus no well will be required to mount the brake.
2. Design
   a. Unit stresses are not to exceed those in existing brakes.
   b. As far as possible, the design of the brakes is to be such that they can be used on the previous series of AISE d-c mill motors.
3. Ratings
   a. Brake ratings will be in accordance with those given in Table I. Ratings are given for ½-hr series and one-hour shunt, 1-hr series and 8-hr shunt.
4. Dimensions
   a. Wheel and mounting dimensions are given in Table I.

Copyright 1952 by Association of Iron and Steel Engineers
Printed in USA.



BRAKE FEATURES:
- LINING WIDTH IS $\frac{1}{4}$" LESS THAN "C."
- NOT MOTOR - MOUNTED.
- NO ENCLOSURE.

MOTOR	SERIES MOTOR LB-FT		BRAKE RATING LB-FT			MOUNTING DIMENSIONS					WHEEL				
	.5 HR.	1 HR.	.5 HR. SERIES 1 HR. SHUNT	1 HR. SERIES	8 HR. SHUNT	A	B	H	Z	J	D	C	E	F	G
2	46	29	100	65	75	$3\frac{1}{4}$	$2\frac{7}{8}$	$\frac{11}{16}$	$8\frac{1}{4}$	7	8	$3\frac{1}{4}$	3	$2\frac{5}{8}$	$2\frac{3}{8}$
602	78	49													
603	116	72	200	130	150	4	$3\frac{1}{8}$	$\frac{11}{16}$	$9\frac{1}{4}$	$8\frac{3}{8}$	10	$3\frac{3}{4}$	$3\frac{1}{2}$	$2\frac{5}{8}$	$2\frac{3}{8}$
604	166	121							$9\frac{3}{4}$						
606	337	228	550	365	400	$5\frac{3}{4}$	$4\frac{1}{2}$	$\frac{13}{16}$	$10\frac{1}{2}$	$9\frac{7}{8}$	13	$5\frac{3}{4}$	4	$3\frac{7}{8}$	$2\frac{1}{8}$
608	502	350							11				$4\frac{1}{2}$	$3\frac{3}{4}$	$2\frac{1}{2}$
610	765	525	1000	650	750	$7\frac{1}{2}$	$5\frac{3}{8}$	$1\frac{1}{16}$	$12\frac{3}{4}$	$12\frac{1}{8}$	16	$6\frac{3}{4}$	$4\frac{1}{2}$	$5\frac{3}{8}$	$3\frac{1}{8}$
612	1220	830	2000	1300	1500	$9\frac{1}{4}$	$6\frac{1}{2}$	$1\frac{1}{16}$	$14\frac{1}{4}$	$13\frac{1}{4}$	19	$8\frac{3}{4}$	5	$6\frac{7}{8}$	$3\frac{1}{8}$
614	1780	1140							$15\frac{1}{4}$						
616	2625	1750	4000	2600	3000	$11\frac{3}{4}$	8	$1\frac{5}{16}$	$17\frac{1}{4}$	$15\frac{7}{8}$	23	$11\frac{1}{4}$	$5\frac{1}{2}$	$8\frac{3}{8}$	$2\frac{5}{8}$
618	3615	2560											6		$3\frac{1}{8}$

TABLE I — AISE D–C MILL MOTOR BRAKE RATINGS AND DIMENSIONS

2 SEPTEMBER 1952

By V. E. SCHLOSSBERG, Chairman, Mill Motor Brake Standardization Committee

AISE MILL MOTOR BRAKE STANDARDIZATION

▲ WITH the coming of the 600 series motor, standardization became advisable due to the desire to eliminate a well for the motor brake. In order to accomplish this purpose, a committee was formed by the AISE with myself as chairman. We in turn called upon NEMA for help with the result that a joint committee was formed to work out this problem. Great credit must be given to the members of the committee who participated in the work:

V. E. Schlossberg, (Chairman AISE Committee), Assistant General Superintendent, Operating Service, Inland Steel Co., East Chicago, Ind.

A. B. Glover, Assistant Electrical Superintendent, Acme Steel Co., Chicago, Ill.

Harry G. Hague, Assistant to Division Superintendent, Maintenance and Utilities, Gary Sheet & Tin Mill, United States Steel Co., Gary, Ind.

J. H. Miller, Superintendent, Maintenance Department, Wisconsin Steel Works, International Harvester Co., Chicago, Ill.

L. A. Terry, Superintendent, Power and Electrical Dept., National Tube Div., United States Steel Co., Gary, Ind.

Paul Thomas, Assistant General Superintendent, United States Steel Co., Gary, Ind.

L. A. Wynd, Electrical Superintendent, Republic Steel Corp., Chicago, Ill.

T. C. Dawson, Electrical Dept., Bethlehem Steel Co., Bethlehem, Pa.

I. E. Madsen, Standards Engineer, Association of Iron and Steel Engineers, Pittsburgh, Pa.

P. B. Harwood (Chairman, NEMA Committee), Vice President in Charge of Engineering, Cutler-Hammer, Inc., Milwaukee, Wis.

John A. Cortelli, Chief Engineer, Clark Controller Co., Cleveland, Ohio.

J. D. Leitch, Vice President and Chief Engineer, Electric Controller and Manufacturing Co., Cleveland, Ohio.

S. Rifkin, Materials Handling Div., Industry Engineering Divisions, General Electric Co., Schenectady, N. Y.

G. L. Bennett, General Electric Co., Schenectady, N. Y.

I. R. Smith, Westinghouse Electric Corp., Buffalo, N. Y.

G. A. Moffett, General Electric Co., Schenectady, N. Y.

R. W. Shartle, Wagner Electric Corp., St. Louis, Mo.

J. S. Smith, Wagner Electric Corp., St. Louis, Mo.

H. E. Hodgson, Cutler-Hammer, Inc., Milwaukee, Wis.

H. B. Stoddard, NEMA Staff, New York, N. Y.

C. B. Hathaway, Westinghouse Electric Corp., Buffalo, N. Y.

A. E. Lillquist, Supervising Engineer, Cutler-Hammer, Inc., Milwaukee, Wis.

The following requirements were laid down by the AISE as the objective in the standardization:

1. All manufacturers' brakes of a given size shall be interchangeable with respect to:
   a. Mounting dimensions.
   b. Torque ratings.
   c. Wheel dimensions.
2. All brakes must be applicable to the 600 series of mill motors in such a way that the height from the center line of the wheel to the base of the brake shall be at least 1/8 in. less than the height from the center line of the motor shaft to the base of the motor.

With the previous objectives in mind, a series of brakes was proposed by the NEMA members similar to those shown in Table I of the standard. *(Editor's Note: At time of giving this report, the J dimension was given as a maximum dimension instead of a fixed dimension.)*

It will be noted that these six brakes cover eleven sizes of motors. Wherever a given brake size is used for two motors, the above AISE requirements with respect to mounting dimensions must be met for the smaller motor, while the torque capacity must also be adequate for the larger of the two motors.

The area of a brake wheel for a given size of brake is determined by its ability to dissipate heat under given temperature limitations. The maximum diameter of the wheel being determined by the height limitations above, the minimum width of the wheel is automatically established.

When brakes are designed in accordance with these requirements, their dimensions are such as to determine the minimum value of the "Z" dimension shown. This "Z" dimension, along with the resultant width of the wheel, produces some overhang of the rim beyond the hub. If this overhang is not acceptable it will be necessary to alter the original requirements.

A copy of the new standard line of brakes shown in Table I was sent to the steel producing industry and their comments requested. As a result of this poll, 96 per cent of the people who were polled approved of the brake standard, 3 per cent disapproved and 1 per cent did not reply.

In addition, there are a number of comments among which the following were the most important:

1. Reduce Z dimension.
2. Reduce G dimension.
3. Prefer brake wheel diameters of 6 in., 8 in., 10 in., 14 in., 18 in., 21 in. and 24 in.
4. Torque rating was questioned because of small brake wheel diameters.
5. Standardize J dimensions.

In order to discuss these points, the Mill Motor Brake Standardization Committee met on the morning of October 3, 1951. Taking up the five questions in their order, the first proposal was:

1. Reduce the Z dimension. The discussion brought out that the Z dimension could not be reduced because the magnet coil brings up difficulties.

2. Reduce the G dimension. The G dimension could not be reduced because this dimension is set by the Z dimension.

3. Prefer brake wheel diameters of 6, 8, 10, 14, 18, 21 and 24 in. After a great deal of discussion, it was determined that brake wheel sizes could not be changed. In several cases, if they were made larger to suit the suggested diameters, it would be necessary to dig the wheel or allow for a well. In other cases, if they were made smaller, they would give higher stresses on the wheel. This comment is particularly pertinent to the 13-in. wheel.

4. The torque capacity was questioned because of the smaller brake wheel diameter. The committee discussion brought out the fact that the brakes would easily have the capacity given on the rating sheet. The manufacturers were particularly specific on this point.

5. Standardize J dimension. The question as to whether the manufacturers could standardize on the J dimension is one that the manufacturers are now studying as indicated in the above report. (This has since been done).

If anything, the meeting brought out the fact that the proposed standard is closer to existing practice and equipment than was first realized by the members of the AISE when they saw the new rating sheet. One factor which apparently had raised some of the doubt was the fact that the sketches on the rating sheet were not drawn to scale and gave an impression that such items as overhang were much worse than existing practice. Without going into all the details, the survey made at this meeting definitely showed that when the dimensions of the proposed standard were analyzed and compared with the same equipment now being furnished the steel industry that the differences are minor.

As previously mentioned 3 per cent of the people polled had disapproved the brake specification. An appreciable number of these were guests at the committee meeting, and as a result of the discussion, they were convinced that the new standard would be satisfactory and would do the job required. After consideration, the committee voted and approved the standard on the following motion: "The J dimension be made a definite dimension and the standard be adopted."

The opinions given by last summer's survey, and the comments made at the brake committee meeting, and at the standardization session, definitely indicate that the new brake meets favor with the industry.

DISCUSSION

PRESENTED BY

JOHN LEITCH, Vice President and Chief Engineer, Electric Controller and Manufacturing Co., Cleveland, Ohio

F. SANTIAGO, Electrical Engineer, The Wellman Engineering Co., Cleveland, Ohio

V. E. SCHLOSSBERG, Assistant General Superintendent, Operating Service, Inland Steel Co., East Chicago, Ind.

John Leitch: When we were first presented with the requirements outlined, we felt that the AISE was asking altogether too much. If you were to look over the dimensions of most of the brakes that are manufactured today, you would find that on the larger sizes, a hole must be dug, in applying them to the 400 series of motors, and, consequently, when these requirements are applied to the 600 series of motors where for a given horsepower the frame size is one size smaller, the difficulty is further increased. However, I can assure you, on behalf of the NEMA group on this committee, that we feel quite confident that the new line of brakes, as proposed here, will be very satisfactory from a point of view of stresses.

In the new design of brakes, we have used the same unit pressure between the wheel and the shoe as on the old design, and since the requirements force us to use wheels of smaller diameters, it is obviously necessary that they be wider, and consequently, the Z dimension becomes greater than perhaps you like. Immediately the Z dimension is fixed, the G dimension is also fixed. Therefore if you do not like the result, it will be necessary to change the requirements.

It is interesting to note that all of us manufacturers on this brake committee started to design these brakes in accordance with the requirements independently and separately. We met on two or three occasions and discussed what we found, and of course, since we all used the same physical laws and the same mathematical equations, we obtained the same answer. So that is how it is, and there is nothing that can be done about it. We cannot change the physical laws, and if you do not like the Z dimension, it will be necessary to change the requirements regarding the J dimension.

Regarding the J dimension, which is shown as "J Maximum," it would be desirable that this dimension be standardized. (Editor's note: This has been done.) We do not know yet exactly what the J dimension will be, but it certainly will be the "J Maximum" for the larger sizes of brakes and it might be that this statement will also apply to the smaller sizes.

F. Santiago: I would like to ask Mr. Schlossberg about the three per cent who disapproved the standard. Were they equipment manufacturers or operating personnel?

V. E. Schlossberg: Of the three per cent that disapproved, some were equipment manufacturers.

F. Santiago: I never heard of the questionnaire. I am concerned about dimension "Z," especially in charging machines. If we increase the Z dimension, it is going to be kind of tough to stay within the specified space.

V. E. Schlossberg: When you talk about charging machines, you talk about fifty horsepower. You are in the ratings 610 and 608. If you check this size you will find the Z dimensions are all in accordance with the present line of brakes.

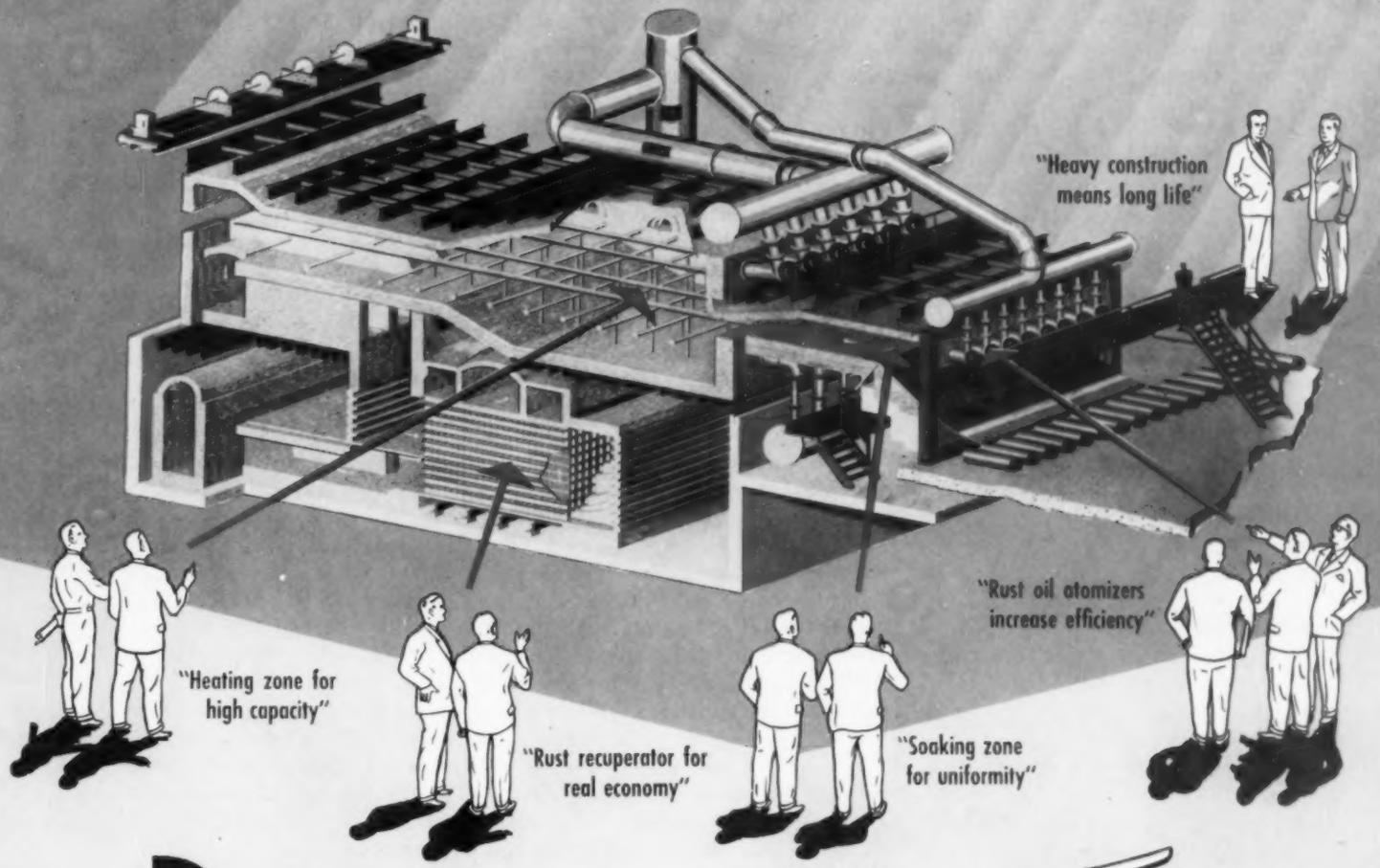
F. Santiago: In other words, it will not interfere any more than the present magnetic brakes?

V. E. Schlossberg: That is correct.

F. Santiago: Sometimes we have trouble fitting the present brakes in the space available, especially the two magnet type.

V. E. Schlossberg: We have not simplified the problem that is brought about by the magnet coil. You have to have room to get the magnet coil in and if you want a good brake, you have to make the magnet coil big enough to release the brake if you have a low motor current or a high motor current.

FURNACE MEN KNOW THEY'RE BETTER


"Heavy construction means long life"
"Rust oil atomizers increase efficiency"
"Heating zone for high capacity"
"Rust recuperator for real economy"
"Soaking zone for uniformity"

RUST *Continuous Reheating Furnaces*

PROVIDE ACCURATE TEMPERATURE CONTROL.. FOR SLABS, BLOOMS, BILLETS, BARS, ETC.

Yes, furnace men know the advantages of Rust's patented zone controlled, double or triple-fired, recuperative, continuous furnaces. They give positive, automatic control of heating quality and tonnage output. Each furnace is individually designed to meet specific needs and provides 100% accuracy in the control of predetermined heating temperatures. Flexibility is achieved by simply changing the fuel firing rate in the heating zone. It means maximum heating efficiency with a minimum of fuel.

In addition to reheating furnaces, Rust builds other types (designed for any fuel) for practically all metallurgical heating needs. For either new or modernization projects let Rust quote on your requirements.

THE WHOLE JOB IS ONE JOB WITH A

RUST "PACKAGE" CONTRACT

One contract covers everything . . . from blue print through start up. Rust assumes responsibility for design, manufacture, erection, and is prepared to undertake all phases of the work with its own forces, including wiring and piping. This results in substantial savings . . . One profit instead of pyramiding ones which accrue where many subs are employed.

RUST FURNACE COMPANY

Pioneers in Furnace Design

RUST BUILDING **PITTSBURGH, PA.**

HYDRAULIC ROLL LATHE REDUCES ROLL DRESSING TIME

▲ A new hydraulic roll lathe with patented features has been developed. The first commercial unit is a 60-in. roll lathe, the largest size commercially produced. This is to be installed at the new Fairless Works of U. S. Steel. It was developed and built by Blaw-Knox Co.'s Lewis Foundry & Machine Division at Groveton, Pa.

Although this 60-in. machine is the first unit manufactured for sale, Blaw-Knox has been testing the new lathe features in its own roll-making shops for several years. Company engineers and production people report that the use of the hydraulic lathes has produced time savings of up to 75 per cent in roll machining where substantial rough machining is required.

The lathe has three hydraulic features and one other improvement which save time and effort. The in-feed or bite of the cutting tool, the lateral movement or traverse of the tool, and the movement of the tail stock all are controlled by hydraulic pressure. These features relieve the lathe operator of much heavy manual work, increase the consistency and uniformity of the cutting operation and produce savings in time. For example, moving the tail stock on manual roll lathes normally requires two men and a bar and may require crane service.

The new lathe has other improvements, such as adjustable neck bearings, which make the bearing adjustment more true and reduce the demands on driving equipment, spindles and back bearings.

Chief saving in time is achieved by converting the roll machining operation from what is essentially a manual, intermittent task to something approaching continuous flow. Roll lathes normally do not have lateral traverse. They employ the plunge cut. After the tool is set up, the operator forces it into the face of the revolving roll with a feed screw; the pressure is maintained manually and enough revolutions are made until the desired depth of cut has been reached. The operator must make repeated measurements and control wedges at the side of the cutting tool to maintain squareness. Then the tool is retracted, moved over to its next position, and another plunge cut taken. The hydraulic lathe is equipped with a tool traverse carriage that introduces a continuous spiral, or what is known as a traverse cut. This not only eliminates considerable set-up time, but the pressure is constant, thus minimizing variation and the need for adjustments.

Other advantages are as follows:

The width of cut can be increased, from a maximum of about 5 in. on manual roll lathes to as much as 8 in. in some cases.

The in-feed or depth of cut can be increased, so long as the tool material can "take it." This is because the hydraulic pressure is pre-determined and constant, eliminating wobble; the constancy of in-feed pressure reduces the hazard of shock impact that is so destructive to some of the modern cutting tools, such as the tungsten carbide tipped tools.

The speed of cutting, that is the revolving rate of the roll, can be increased where certain modern tool materials such as the carbides are employed.

The use of hydraulic pressure will permit the rough machining of certain very hard surface rolls which cannot be machined at all on manual lathes; formerly, such rolls had to be subjected to rough grinding, a very costly operation.

The hydraulic lathe makes it feasible to operate several cutting tools simultaneously, perhaps one on each side of the roll or two tools working at opposite ends on the same side of the roll.

The traverse carriage operates both from left to right, and right to left, again saving tool set-up time.

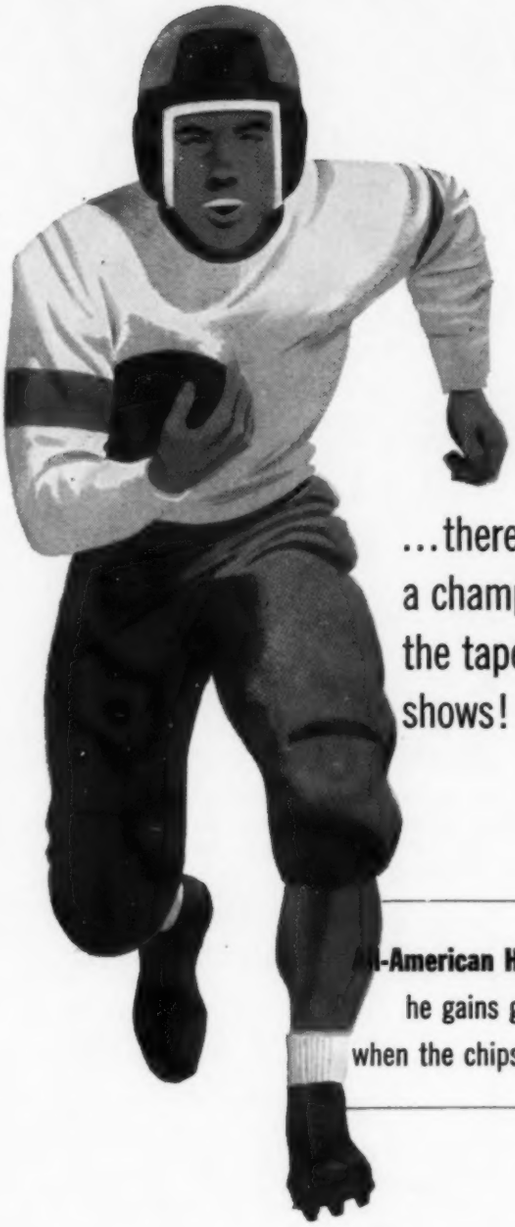
The roll is supported in the hydraulic lathe on adjustable neck bearings, eliminating the weight on the centers. This reduces center wear, avoiding the occasions when re-centering is required, and also avoids the need for excessive grinding or finishing to achieve trueness.

As indicated, the hydraulic control of the tail stock saves manual effort, reduces crane service, and contributes to safety.

This particular machine built for U. S. Steel is equipped with a 60-hp main drive motor with variable speed from 300 to 1,200 rpm, and a separate motor for the hydraulic pumps. The pumps are designed to maintain a hydraulic pressure of 1,000 psi in each of the cylinders.

Figure 1 — This hydraulic roll lathe, the first commercial unit of a newly developed design, was built for installation at the new Fairless works.

IT'S PERFORMANCE THAT COUNTS



...there's more to a champion than the tape measure shows!

All-American Halfback...
he gains ground
when the chips are down.

Average Halfback...
he may measure
the same... but he's
stopped in the tough ones.

HARDTEM DIE BLOCKS* perform like "champions" in your production line!

Heppenstall Hardtem Die Blocks perform like "champions" because they possess those extras that result in superior quality. Their patented steel analysis resists softening and heat checking in service. Records from plants using Hardtem Die Blocks provide the following benefits for production:

- ★ Longer Production Runs
- ★ Long Life of Dies
- ★ Lower Overall Die Cost
- ★ Less Down Time
- ★ Holding of True Dimensions

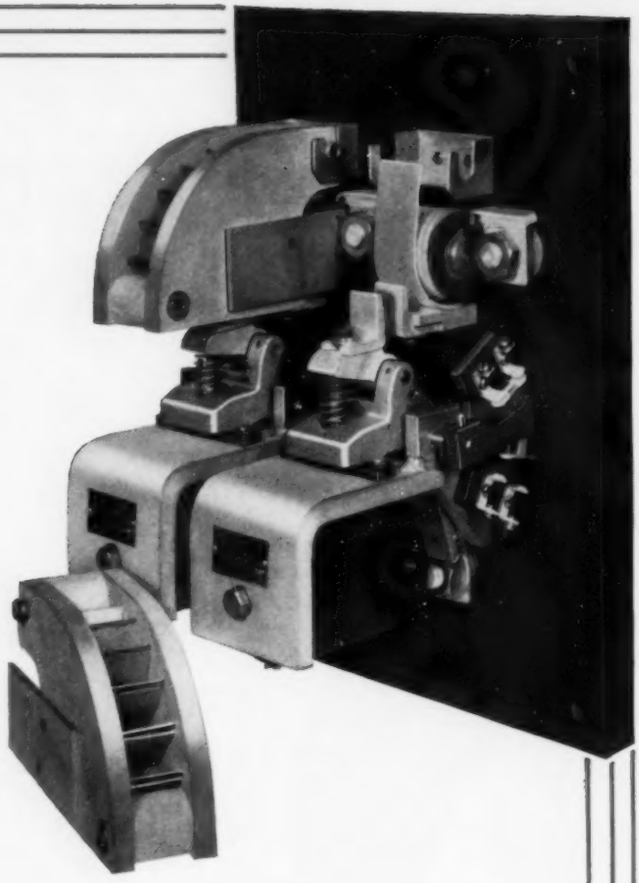
It will pay you to try Hardtem Die Blocks.
Call Heppenstall Company, Pittsburgh 1, Pa.
Sales offices in principal cities.

Heppenstall

The most dependable name in die blocks

Developed

...with Steel Industry Cooperation



EXHAUSTIVE FIELD AND FACTORY TESTS have proved the remarkable durability of the new Type 260 DC Contactor. In the development of this heavy duty contactor, Allis-Chalmers engineers consulted and worked with steel mills . . . to meet their exacting requirements . . . to comply with their design preferences . . . *to assure you efficient, reliable performance under the most severe operating conditions.*

ALLIS-CHALMERS
Mill Type 260 DC CONTACTOR

Check these Advantages:

INCREASED CONTACT AND CHUTE LIFE — Contact erosion and chute carbonization are reduced by an entirely new and exclusive principle of arc interruption. Pronounced rolling action of the heavy forged copper main contacts minimizes destructive scuffing and extends contact life.

QUICK, EASY INSPECTION — Contacts are exposed for inspection by merely *lifting* arc chute. Each contact is held by a single screw. Auxiliary contacts are mounted on contactor frame in full view. Operating coil is supported by one bolt.

REDUCED MAINTENANCE — No field adjustments are necessary. Silver alloy auxiliary contacts need no dressing. Permanently lubricated *Oilite* bearings, running on stainless steel shaft, eliminate pivot oiling.

DESIGNED FOR EASY MOUNTING — As a replacement device, the Type 260 Contactor can be mounted on insulating panels from 1¼ to 1½ inches thick. No additional drilling is required for electrical interlocks, since they are mounted on the contactor frame.

Call your nearby A-C district office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 14B6505A. A-3911

ALLIS-CHALMERS A-C ALLIS-CHALMERS

NEW Fast Arc Centering Blowout

Arc Chute Assembly consists of triangular metal plates with U-shaped segments mounted alternately. Plates are insulated from each other and are placed at right angles to circumference of contact travel.

Metallic segments act as individual blowout coils.

Arc is forced upward along arc runner by blowout coil and impinges on metal segment of arc chute.

As contacts separate further, arc is stretched across an increased number of segments.

Arc rises quickly due to thermal and magnetic action of each individual metal segment.

Tapping one of the new 20-ft top charge electric arc furnaces at The Timken Roller Bearing Co. This furnace uses the first electro-magnetic inductive stirrer on an electric arc furnace in the United States.

TIMKEN REPLACES OPEN HEARTHS WITH ELECTRIC FURNACES

▲ The replacement of three 125-ton open hearth furnaces with three modern 20-ft top charge electric arc furnaces at the Timken Steel and Tube Division of The Timken Roller Bearing Co. at Canton, Ohio, is nearing completion. The change was dictated by economic factors and the demand for additional high quality electric furnace alloy steel. The expected increase in production with the new units is about 75,000 tons annually for a total of 625,000 tons of all electric steel.

The last open hearth furnace remaining in The Timken Roller Bearing Co.'s steel operation has already been dismantled, and beginning December 1, 1952, all steel melted at the Timken company will be in electric furnaces.

The last open hearth furnace to operate at the Timken company was installed in 1927. In its 25 years of service it produced more than a million tons of steel, averaging slightly more than 118 tons per heat.

During the past several years, there was a critical shortage of high quality pig iron in the open market which forced a non-integrated shop such as Timken to use substitutes which resulted in unsatisfactory and high cost operation of their open hearth furnaces. Enlargement and modernization of the open hearths would have been to no advantage under these conditions, particularly in alloy steel production. The scrap market, while often tight, did not present the same obstacle as the pig iron market. It was advisable therefore to depend on the scrap market entirely and replace the open hearths which were built in 1927 and 1928 with modern large electrics which would include all the improvements in design and equipment available. Among the most spectacular of these is the inductive stirrer which with other features will be described in the following paragraphs.

The first furnace, which was put into operation on September 29, 1952, is one of the new 20 ft top charged, swinging roof installations in the Timken melt shop. As accessory equipment, it has the first electro-magnetic inductive stirrer to be used on an electric arc furnace in the U.S.A. and the largest unit of this type in the world. The foundations for this furnace required 650 yards of concrete. Electrical installations are equipped with 26 distinct controls used for operation of the furnace and auxiliary equipment. Twelve direct-current motors and seven motor-generator sets are utilized in running the furnace and the inductive stirrer. The unit with a full heat of steel weighs about 400 tons—the stirrer alone weighing 25 tons. Three separate water systems are employed for cooling the furnace and associated equipment. Included are a recirculating distilled water system for the stirrer, plant deep well water at 56 F for the transformer and other electric equipment, and plant reclaimed water at approximately 85 F to 90 F for furnace coils and other miscellaneous cooling. This report will include some of the more pertinent details of the furnace and its accessory equipment.

FURNACE SHELL AND BOTTOM

The bottom is austenitic stainless steel, type 304, plate 1¼ in. thick and dished to a radius of 22 ft 8 in. Both bottom and shell were shipped in two sections—the bottom sections being welded after arrival at the melt shop and shell sections being bolted together. The bottom was then riveted to the shell so that the planes of the bottom and shell joints make an angle of about 25 degrees. Pertinent dimensions are given as follows:

Shell in inside diameter—20 ft 0 in.
Bottom to top of shell—12 ft 8 in.
Top to fore plate line—6 ft 9 in.
Fore plate line to floor level—2 ft 0 in.
Front door opening—4 ft 0 in. × 3 ft 6 in.
Side door opening—3 ft 5 in. × 3 ft 0 in.
Bath depth—40 in.
Refractory depth—31 in. (Ramset 10 in., magnesite 12 in., fireclay 9 in.)

Masonry materials used for lining and bottom were:

5,000 lb—High temperature cement.
9,000—3-in. clay brick.
150—7 × 9-in. clay brick.
7,500—Magnesite brick, straights and keys.
1,500—13½ × 6 in. Magnesite straights, steel clad.
2,000—13½ × 6 in. Magnesite keys, steel clad.
7,500 lb—Hydrocon.
32,000 lb—Ramset.
900 lb—Open hearth slag.
3,750—9 × 2½ in. Clay brick used on protective apron beneath furnace.
50—9 × 3 in. Carbon brick in slag apron.

ROOF

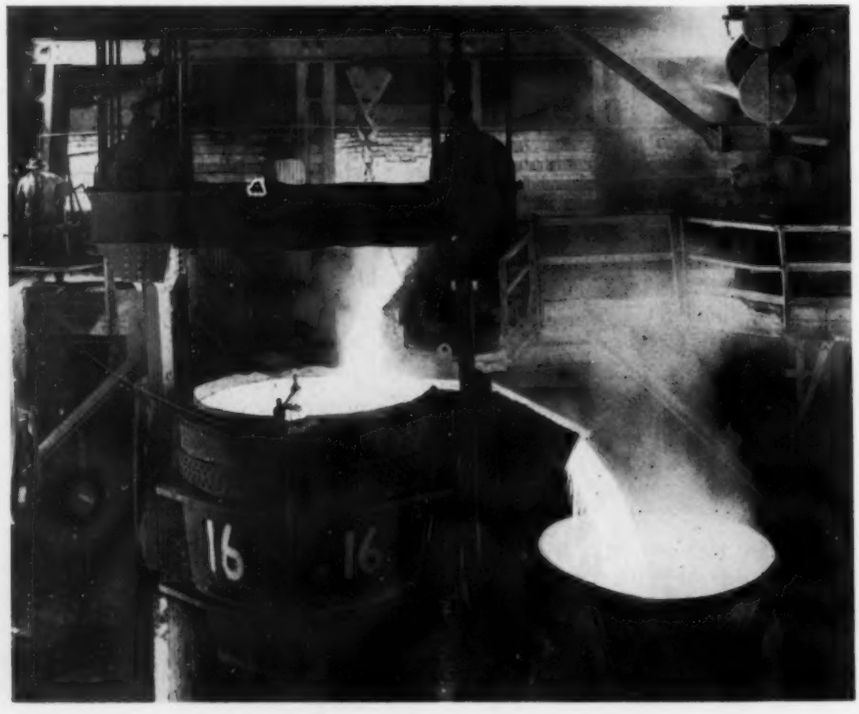
Details of roof are as follows:

Roof ring—20 ft 8 in. diam × 1 ft 6 in. The roof ring is water cooled, the water flowing through a welded duct of triangular cross-section.
Electrode pitch circle—5 ft 0 in.
Electrode opening—2 ft 0 in.
Rise of roof—27¼ in.

Masonry materials used for roof were:

50—12 × 6 × 2 in. Silica brick.
38—12 × 6 × 2½ in. Silica brick.
75—12 × 6 × 3 in. Silica brick.
325—No. 1 W Silica brick.
625—No. 2 W Silica brick.
150—Key W Silica brick.
75—No. 3 W Silica brick.
850—No. 1 A Silica brick.
200—No. 2 A Silica brick.
40—No. 3 A Silica brick.
25—Feather edge Silica brick.
18—15 in. No. 1 W Silica brick.
1750 lb—Tayco cement.

Last heat from an open hearth furnace at the Timken Roller Bearing Company is being poured.



TILTING MECHANISM

Data on tilting mechanism is as follows:

Foreward tilt—40 degrees in 85 sec.
Backward tilt—15 degrees in 31.7 sec.
Driving motor—25-hp, Compound-wound, mill type.

ROOF SWING

The roof is suspended at four points on the roof ring by roller chains from two lifting arms. All four chains are hoisted simultaneously by two 7½-hp compound-wound mill type motors, mounted one on each lifting arm, to lift the roof off the shell. Lift distance is 1 ft 6 in., or a height equal to the thickness of the roof ring. The roof is swung toward the charging floor through an arc of 60 degrees. Since the electrode masts and winches are carried in this swinging superstructure, or rotary platform, the masts must be raised up through the floor plates before the roof is swung. In normal operation, this rotary platform is restrained from movement by a pin driven pneumatically from a station at the rear of the swinging superstructure into a socket in the floor plate. When the roof is swung, this pin is retracted and a pneumatically operated wedge is driven between the furnace platform and a column beneath the furnace to relieve some of the strain placed on the supporting members of the furnace platform by the change in weight distribution. The roof swing mechanism is equipped with limit switches at both extremes of the traverse, set so that the roof comes to rest gently instead of coming forcibly in contact with a fixed stop. Proper seating of the roof upon the shell is assured by pins on the shell which fit into corresponding holes in the roof ring.

DOOR LIFTING EQUIPMENT

The door lifting arrangement resembles the electrode lifting assembly with moving arm and mast instead of the chain and crank type of lifting device which is used on the other furnaces. The lifting mechanisms for both doors are driven by 5-hp compound-wound mill type motors which give following times for lift.

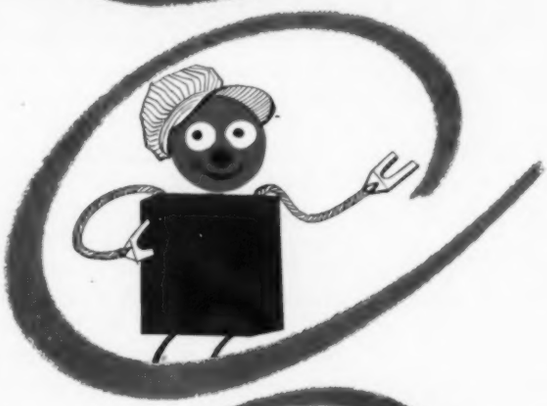
Side door—Lift 3 ft 2 in., 38.9 fpm, or 4.88 sec for full lift.
Front door—Lift 3 ft 8 in., 38.9 fpm, or 5.65 sec for full lift.

HERE'S HOW YOU SAVE TIME, CUT COSTS WITH NATIONAL STANDARDIZED BRUSHES

TRADE - MARK

MR. ELECTRICAL SUPERINTENDENT

. . . "National" STANDARDIZED brushes greatly simplify the application of brushes to your motors and generators. You *start* right, *stay* right with brushes designed specifically for uninterrupted machine operation.



MR. MAINTENANCE MAN

. . . "National" STANDARDIZED brushes provide the ideal commutation and low friction that spell reduced maintenance cost and sustained, economical operation. Carefully controlled brush grades and tamped-type, vibration-resistant shunt connections team up to help *you*.

MR. PURCHASING AGENT

. . . "National" STANDARDIZED brushes greatly simplify ordering. They are shipped from stock—FAST—and at the same low cost for 100 or 100,000 brushes. You can carry smaller inventory . . . stock fewer *different* items — and save money in the bargain!

Write for Bulletin CP-2426
"National" Standardized Brushes

DOLLARS *and* SENSE . . .

point to "Eveready" No. 1050 Industrial Flashlight Batteries . . . delivering twice as much usable light as any battery we've ever made before. Their unique construction prevents swelling or jamming in the case . . . no metal can to leak or corrode.

The terms "National" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation

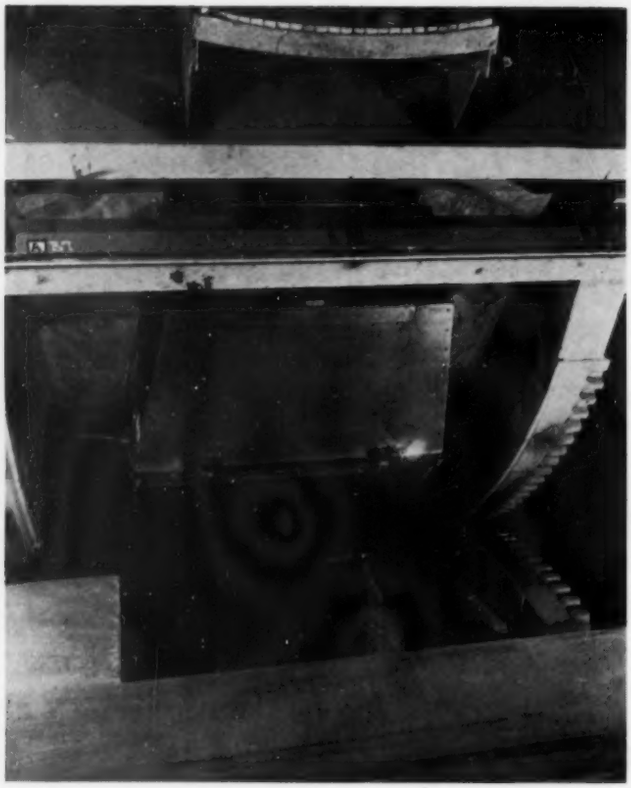
NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices:
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

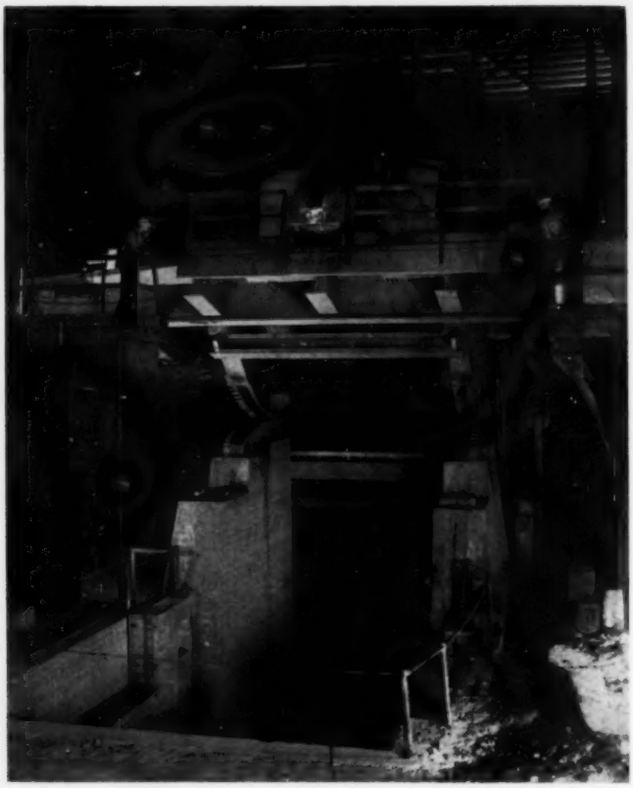
In Canada:
National Carbon Limited
Montreal, Toronto, Winnipeg

NATIONAL STANDARDIZED BRUSHES

BETTER— PRODUCT—PACKAGE—PRICE— FASTER



Close-up view of inductive stirrer is taken from slag-off door side.



View from tapping side of furnace shows inductive stirrer under bottom plate.

ELECTRODES AND ELECTRODE HOIST EQUIPMENT

The electrode holders are pneumatically operated, controlled at floor level from a station located adjacent to the operator's panel. Both masts and arms are welded hollow square sections. The masts are 23 ft 9½ in. in length and the mast stroke is 11 ft 8 in. The hoists are driven by 10-hp shunt-wound mill type motors operating at speeds ranging from 0 to 1600 rpm. The regulating control equipment is of the rotating type utilizing three special motor-generator sets with a separate exciter. Electrical connection between the transformer and the furnace is made by two water cooled cables per phase with a configuration arranged to give the lowest possible reactance. Data on electrode travel is as follows:

Electrode travel, raising—58.6 ipm, or 2.39 min for full stroke.

Electrode travel, lowering—29.3 ipm, or 4.78 min for full stroke.

TRANSFORMER

The furnace transformer has a capacity of 20,000 kva at 55 C. Weight is 76 tons. Primary voltage is 23,400. Selected Secondary voltage taps are:

1. 370 V
2. 310 V
3. 280 V
4. 231 V
5. 179 V
6. 144 V

Available voltages are:

Delta	*Wye*
400	231
370	214
340	196
310	179
280	162
250	144

CIRCUIT BREAKER

The furnace transformer operating circuit breaker is of the air blast type, built for frequent operation but with low interrupting capacity. This breaker is non-automatic, over-current protection being provided by a backup feeder breaker located at the main sub-station several thousand feet from the furnace building. Each backup breaker and feeder will supply power to two furnaces. A special air compressor has been installed to provide clean dry air to the air blast furnace breakers.

TAP CHANGER

The motor operated no-load tap changer is built as an integral part of the transformer and is operated from the furnace control panel. Six voltages are available to the operator, the power input at the three highest voltage is preset while the input at the three lower voltage is under manual rheostatic control by the furnace operator.

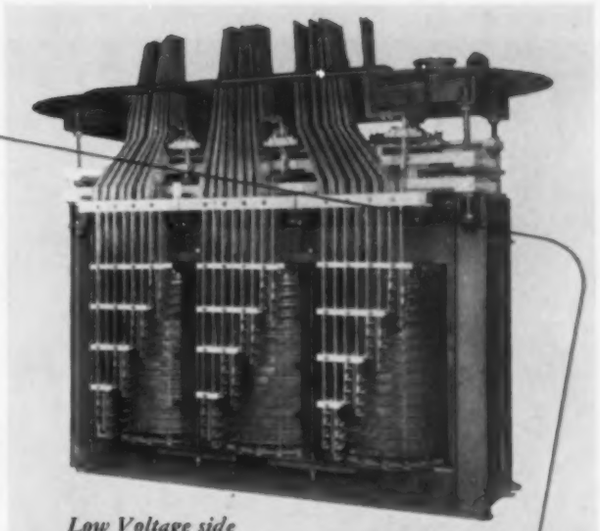
PROVISIONS FOR SLAG OFF

The slag pot is set on a car which is driven forward between the piers supporting the furnace rockers to the pit where the slag pot may be emptied. A special brick drip plate is attached below the slag-off lip to protect the beams supporting the furnace platform. A bricked protecting apron shields the shafts and gears of the tilting mechanism from hot slag which might fall there.

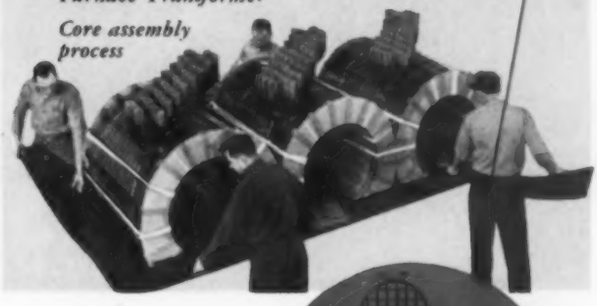
LUBRICATION EQUIPMENT

Lubrication points on the furnace

How Pennsylvania solves 3 major Furnace Transformer Problems



Low Voltage side of 18,000 Kva Furnace Transformer



Core assembly process

The complicated design of a furnace transformer presents many problems that do not apply to other types of transformers. Many special conditions such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses must be met by engineering skill and highly perfected workmanship. Here is how Pennsylvania Transformer Company solves three of these major problems:

1. **OVERLOADS AND SHORT CIRCUIT STRESSES** Electric Furnace operation inherently subjects Furnace Transformers to frequent short circuits and heavy overloads. The effect of this on the transformer is complicated by the wide range of voltages which necessitates cutting out large portions of the primary windings. The effects of both the radial and axial short circuit forces are greatly reduced in Pennsylvania Furnace Transformers by the use of Circular Coils and an ingenious winding arrangement.

2. **BALANCING OF STRESSES** Pennsylvania coils are balanced to reduce the radial and axial short circuit stresses to a minimum. 1. The circular shape protects the coils against deformation due to radial short circuit forces. 2. The total axial short circuit force is calculated for each design and the coils are subjected to an equivalent pressure in an hydraulic press. The ability of the coils to maintain their shape, under the prescribed pressure, guarantees that the transformer will safely withstand short circuits.

3. **DISTRIBUTION OF CURRENTS** Due to the heavy secondary currents, the winding must be subdivided into numerous parallel sections. A unique arrangement of the windings insures that each section carries an equal share of the current.

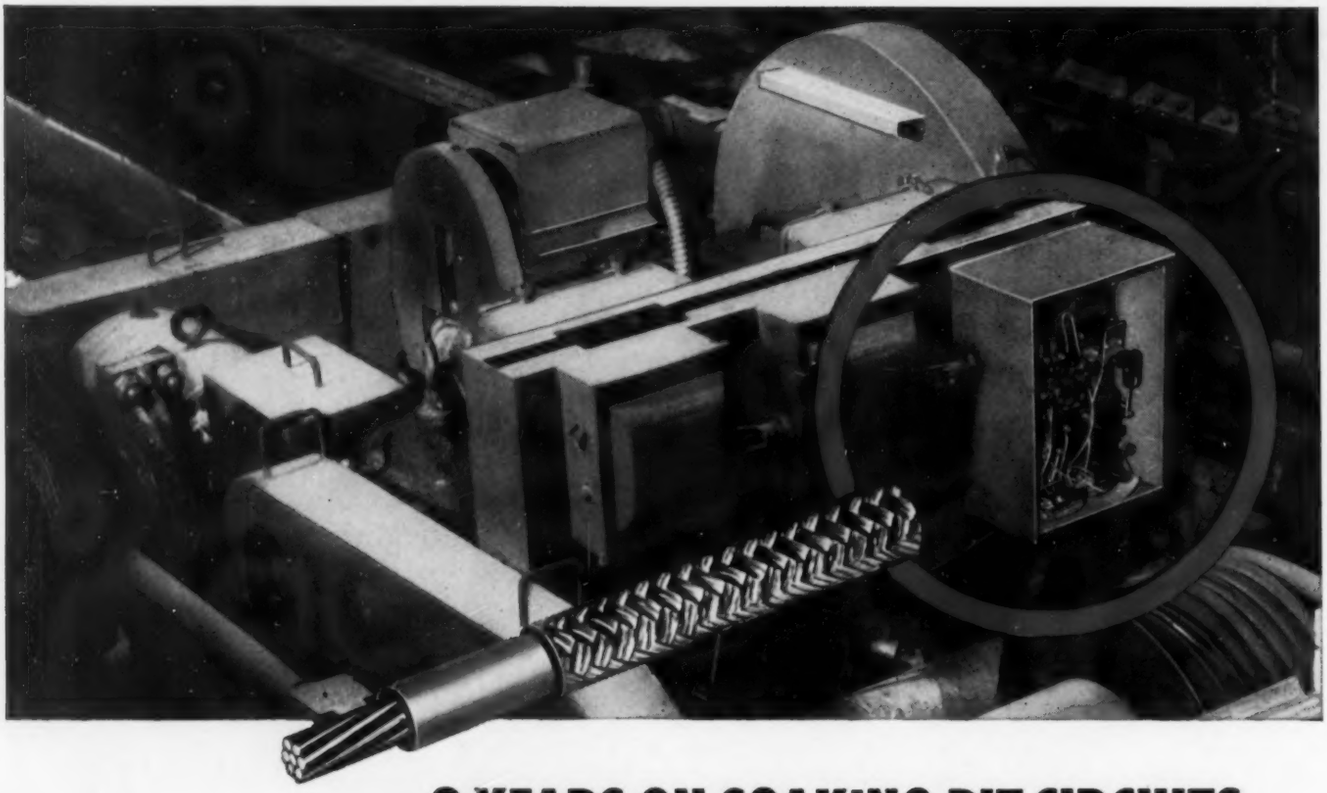
   Careful transposition of the individual conductors of each section in the windings reduces the copper eddy losses to a minimum. This results in improved efficiency, more uniform copper temperature and prevention of hot spots.

Furnace Transformer Experts

Pennsylvania TRANSFORMERS

Pennsylvania TRANSFORMER COMPANY

CANONSBURG, PENNSYLVANIA *Greater Pittsburgh District*



2 YEARS ON SOAKING PIT CIRCUITS

and still like new:

OKOTHERM CONTROL WIRE

With a pit temperature of 2400° and an ambient temperature way in excess of 300° F, the soaking pit shown above is an extremely tough test of control wiring.

Before using Okotherm, this steel mill equipped its soaking pits with asbestos insulated control wire. This wire, however, lasted an average of only two months. Replacing the asbestos wiring circuits meant that the pit had to be shut down; this involved cooling and reheating periods for each pit. Obviously, production was interrupted every two months or so, with considerable material, repair and maintenance costs also involved.

In September 1950, Okotherm cable was installed. *Since that time, no replacement has been necessary.* As of October 1952 the Okotherm cable is still in excellent condition!

Okotherm insulation, a silicone rubber compound developed by Okonite, maintains excellent electrical and physical properties over an extremely wide temperature range. High moisture resistance is another Okotherm characteristic. From printing presses to jet engines, Okotherm has successfully replaced other types of heat-resisting wires with overall savings as high as 88%.

Soaking pit circuits are only one of its many steel mill uses when high temperatures present a problem. Why not ask your Okonite representative about Okotherm insulation today? The Okonite Company, Passaic, N.J.

The best cable is your best policy

OKONITE OKONITE SINCE 1878 *insulated wires and cables*

1408

equipment are serviced by centralized lubricating systems. There are three stations with manually-operated pumps and one with a motor-driven pump which force the lubricating medium to all grease points.

INDUCTION STIRRER

This device is a water cooled coil resembling a segment of the stator of a large two-phase induction motor. The stirring coils are encased in a steel container, or box, which is curved lengthwise only to fit the furnace bottom contour. The box is 12 ft 6 in. long, 7 ft 10 in. wide and 27 in. thick and is suspended beneath the furnace at a distance which may be as little as 2 in. from the bottom plate of the furnace. The top of the stirrer container is covered with a layer of Kaocast, 1 to 1½ in. thick, which serves as an insulator. The stirrer assembly, including coils and container, weighs 51,000 lb. The coil is protected from possible adverse effects of overheating by a warning system which is temperature actuated. This system consists of thermocouples installed at fourteen points in the coils, and twenty positions on the furnace bottom, and one which indicates the temperature of the water in the coil cooling system. These temperature measuring devices are set to trip an alarm system if a predetermined maximum safe temperature is exceeded. When the alarm system for the furnace bottom is tripped, a horn will sound and the stirrer will automatically be stopped. If the coil or its coolant have become overheated, a bell will sound and the stirrer will also be stopped. In any event, signal lights indicate the nature of the trouble and the exact hot spot may be found by manipulation of indicating temperature dials on the panel board which may be connected into any one of the thermistors.

Current is supplied to the stirrer by a special two-phase 0.55 cycle commutator type generator rated at 485 kva at 0.43 power factor, driven by a 400-hp, 2300-v synchronous motor. Excitation is provided by a Swedish built Schrage phase and frequency converter with rotating primary and regulating windings and stationary secondary winding. Two power levels are available for stirring action, 215 kva at 150 volts and 390 kva at 200 volts. The moving magnetic field generated by the current flowing in the stirrer coils may be caused to move in either of two opposite directions so that the metal flow in the furnace may be directed up at the spout or up at the slag-off door.

The stirrer coils are wound with rectangular copper tubing through which distilled water is circulated as a coolant, heat being removed by an externally mounted heat exchanger which is cooled by plant well water.

CHARGING EQUIPMENT

With the exception of the heavy crops, which are machine-charged, the charging of the furnace is accomplished with clam-shell bottom buckets. Two bucket sizes are used, one having a capacity of 950 cu ft and the other of 450 cu ft. The smaller bucket is handled on the regular charging buggies but the larger buckets will not clear columns adjacent to the tracks and so must have a special handling scheme. This consists of a subway running between the stockhouse floor and a point beneath a hatchway in the charging floor. Large buckets have 950 cu ft capacity, weigh 28,200 lb, diam is 10 ft 0 in. and height—bale down is 13 ft 9½ in. Small buckets have 450 cu ft capacity, weigh 17,700 lb, diam is 8 ft 6 in., and height—bale down is 10 ft 5 in.

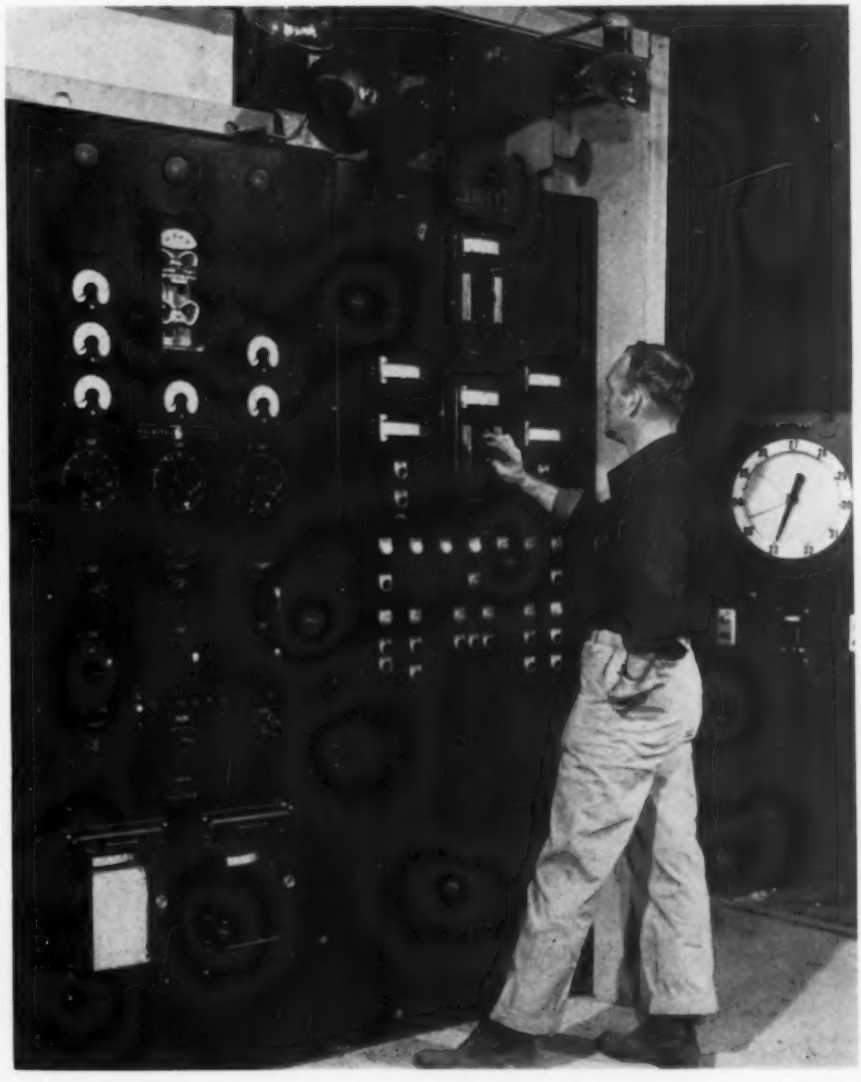
Three 100-ton cars are used for handling two large buckets between scrap yard and melt shop.

Equipment for this new furnace was supplied by the following firms:

Furnace—American Bridge Division of United States Steel Co.

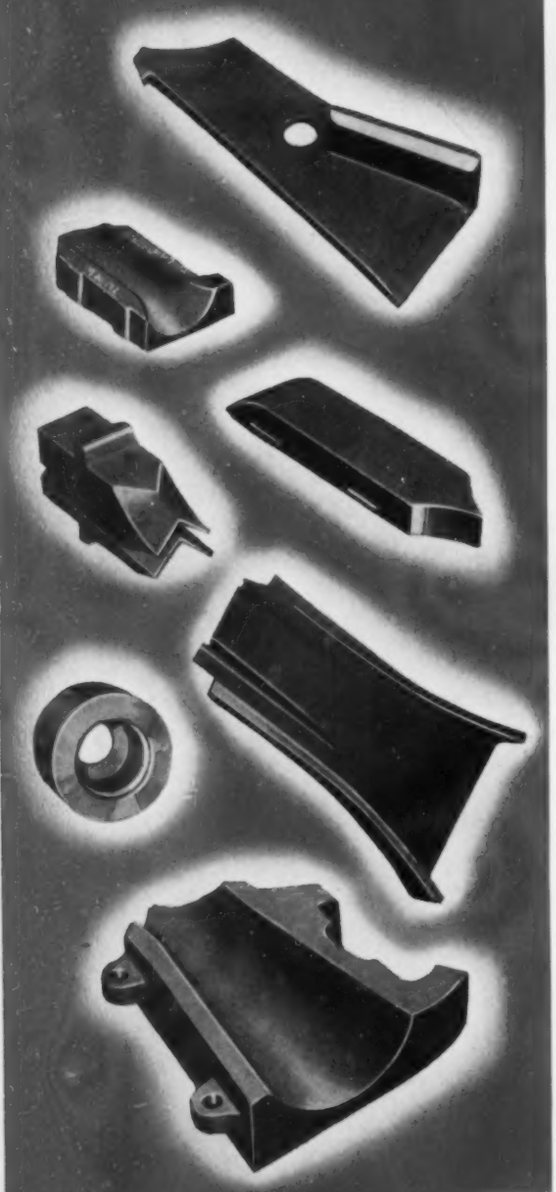
Design—The Timken Roller Bearing Co.

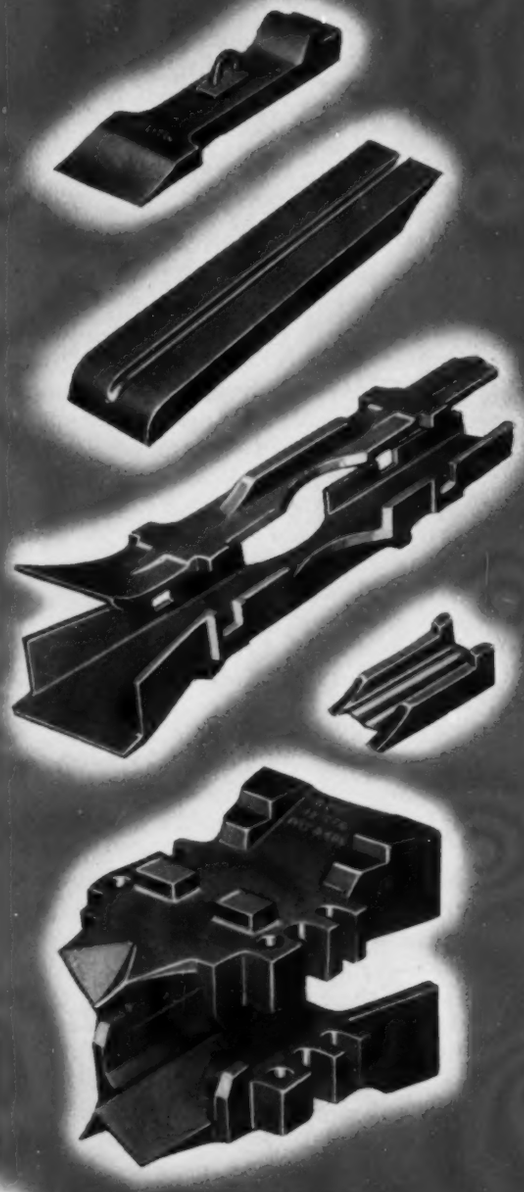
Operator adjusts controls for electro-magnetic inductive stirrer. Control panel at left operates the electric furnace while large dial at right is indicator for the immersion thermocouple.



trantinyl

guides the steel industry





ROLLING MILLS:
bar, hoop, strip, shape
mill guides; and rollers

SEAMLESS TUBE MILLS:
guide shoes, rolling
mill plugs and rolls,
piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing
rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

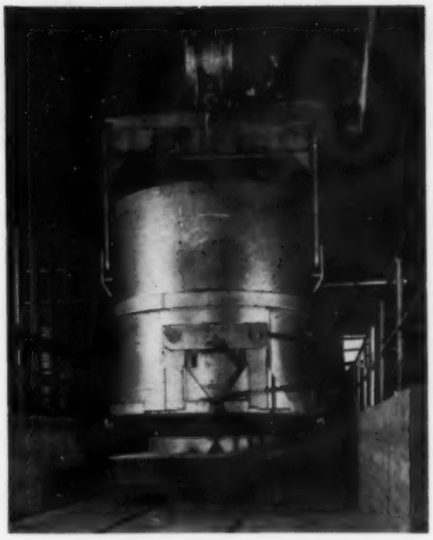
YOUNGSTOWN ALLOY CASTING CORP. • YOUNGSTOWN, OHIO

Erection—Hunter Construction Co.
Magnetic induction stirrer—Built by the Elliott Co. under License from Allmanna Svenska Elektriska Aktiebolaget, Vasteras, Sweden. Represented by Aros Electric Inc., N. Y.
Transformer—Allis-Chalmers Co.
Electrode control equipment—General Electric Co.
Pneumatic electrode holders—Pittsburgh Lectromelt Furnace Corp.
Charging buckets—Central Boiler and Manufacturing Co. and American Bridge Co.
Lubricating system—Farval Corp. and Trabon Engineering Corp.
Circuit breaker—Westinghouse Electric Corp.

The decision to install an inductive stirrer on the first of the new 20 ft electric furnaces at The Timken Roller Bearing Co. was based on an investigation of claims made by Swedish producers, who were using the device, that important economic and metallurgical benefits were obtained.

It is common knowledge to all melters of high quality alloy steels in electric arc furnaces that inert molten metal baths during the refining period are undesirable. Alloying elements tend to stratify and temperature distribution lacks homogeneity. Accurate sampling of the melt thus is practically impossible. Various manual and mechanical methods are now employed to obtain some mixing and stirring action of the metal and slag, but in most cases the effects are only temporary. A better and more flexible method was obviously necessary to improve quality alloy steel production, particularly in the large melting units.

Early in 1948, an electrical device was installed externally under a nonmagnetic bottom plate on a 15-ton Demag furnace at the Uddeholm AB plant in Hagfors, Sweden. The purpose of the instrument was to induce movement of slag and metal at a speed and direction desired by the operator. The method was developed by Prof. Ludwig Dreyfus for ASEA over a period of about ten years of experimental work. He described the inductive stirrer as making use of the induction motor principle. The electric currents in the two phases induce electric current paths in the liquid steel bath. At the same time the two phases generate a moving magnetic field which reacts upon the steel composing the current paths with forces parallel to the furnace bottom.



One of the large charging buckets used to top-charge the furnace. It has a 950-cu ft capacity, weighs 28,200 lb with a diameter of 10 ft.

Interesting data on the benefits of the stirrer on 2-slag heats were supplied by Sven Fornander, who was research manager at Surahammar at the time and Folke Nilsson, general manager at Hagfors. Their reports indicated improved chemical control including lower sulphurs; more accurate temperature determinations with immersion thermocouples; lower oxygen content of the steel than in conventional practice; accelerated chemical reactions between metal and slag; more thorough dissolution of alloys with greater rapidity; more thorough slag-off resulting in lower phosphorous and some other undesirable elements; cleaner steel with a low inclusion count; shorter heat cycles. In addition, many operations about the furnace are facilitated with the use of the stirrer and are more agreeable to the operators.

The experience thus far with inductive stirrers has been on small furnaces. The decision to place a stirrer on a large, high-powered furnace was a bold, forward move. There are some operating factors associated with handling liquid melts which made a cautious approach to the problem advisable. The desire, however, for improving metal quality to produce better bearings, rock bits and other end products demanded that molten metal control should be improved. The inductive stirrer appeared to be a practical device in helping to solve some of the more pertinent problems associated with electric furnace operations.

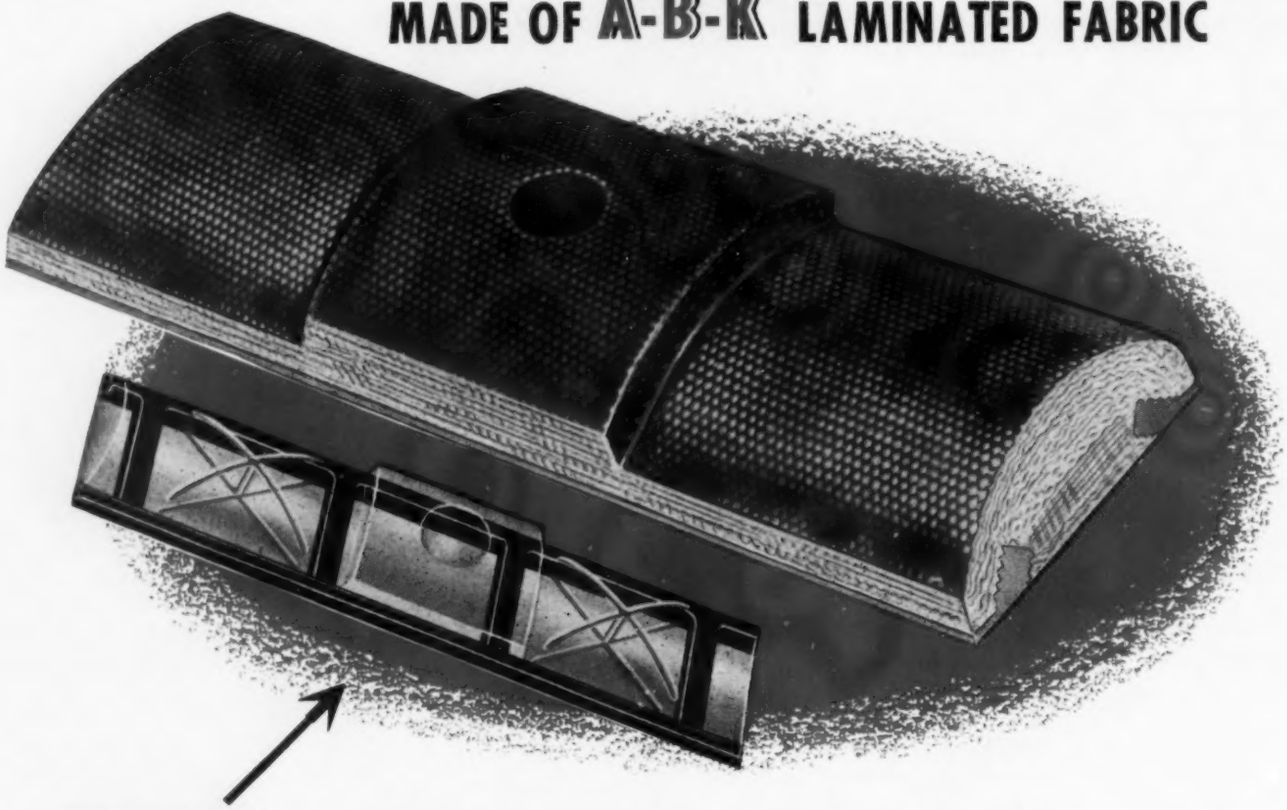
The furnace shell and hearth of the Timken furnace are designed to provide maximum safety to the stirrer and equipment. The danger of a break-through of hot metal which always exists could, of course, be costly. However, steps have been taken to preclude such a contingency.

The first few weeks of operations have been particularly gratifying. However, an extended campaign will be necessary to properly evaluate all the economic aspects of inductive stirring. Some highly important trends indicate a definite improvement in steel quality which can be attributed to the device. Final sulphurs are running about 25 per cent lower than in conventional furnaces. Control of carbon in the final product is unusually accurate. Other elements as well are being held to within narrow ranges. Much of the hard labor is removed from the slagging operation which is also more thorough. Due to the gentle mixing of the bath, slag making during the finishing period is more rapid and can be accomplished with comparatively little effort. Dissolution of alloy additions takes place quickly and homogeneity of the bath is reached in a much shorter time. Temperature measurement of the bath with immersion thermocouples is now more representative of the entire metal mix since thermal stratification is practically non-existent due to the constant turn-over of the bath.

It is obvious from the points noted that the benefits obtained with the stirrer at Timken substantiate many claims made by Swedish operators and supply in a very practical manner a solution in large measure to many of the problems existing in producing high quality alloy steels in large as well as in small arc furnaces.

NOW . . . a *reinforced* slipper bearing

MADE OF A-B-K LAMINATED FABRIC



THE SECRET IS THIS LADDER

This bronze-manganese "ladder", molded in tough A-B-K Fabric, makes a reinforced bearing remarkable for its strength, durability and long life.

A-B-K MATERIAL . . . uniquely reinforced . . . gives remarkable bearing life, exceptional coupling protection

If your present slipper bearings break, wear excessively or need constant maintenance, change to this new A-B-K Bearing.

Made of A-B-K Laminated Fabric, it eliminates metal-to-metal contact. It protects coupling members, will not peen out or take a permanent set. The interlocking, reinforcing "ladder" enables it to withstand exceptionally severe shock loads and strains without splitting or breaking apart. Result: down time is reduced, tonnage is maintained, replacement and maintenance costs are minimized.

Investigate this new A-B-K Reinforced Slipper Bearing. Our engineers will be glad to recommend the right material formula for your specific use.

A-B-K Material Has Many Unusual Properties . . . exceptionally low coefficient of friction . . . highly resistant to shocks and strains . . . excellent structural strength . . . wears slowly and evenly . . . will not score or heat check metal parts . . . good dielectric qualities . . . can be machined to close tolerances . . . grease or water lubricated . . . available in eight different formulas.

If these characteristics suggest a use to you, either as a bearing or for some other component part, A-B-K Engineers will be glad to work with you in its development. Write for our free explanatory folder, today.

A PRODUCT OF

AMERICAN Brake Shoe COMPANY

Copyright 1952 — American Brake Shoe Co.

AMERICAN BRAKEBLOK DIVISION

DETROIT 9, MICHIGAN

IN CANADA: JOSEPH ROBB & CO. LTD., MONTREAL, QUEBEC

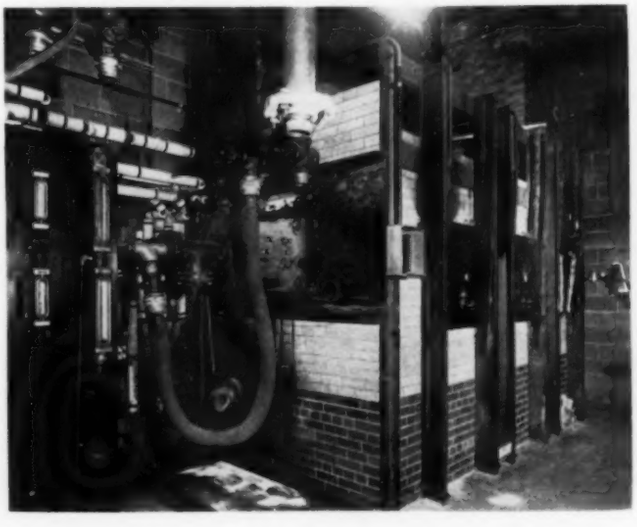
BLOOM ENGINEERING COMPANY EXPANDS FOR BETTER CUSTOMER SERVICE

▲ THE Bloom Engineering Co. held an open house and housewarming to mark the completion of their building program on November 6. This work marks a milestone in the history of the company which was founded as a sole proprietorship in 1935 with one employee, Fred S. Bloom. The company was set up for the purpose of developing a long flame luminous gas burner for application to reheating furnaces for rolling mills. This product was the sole item produced by this company for some time and satisfied a very definite need for the industry which had ordinarily made its own units. As time went on, the company developed a number of other items and in 1936 it added an oil burner to work in combination with the long flame burner. In 1938 a small capacity long flame burner was added, and in 1940 a raw producer gas burner, and in 1942 the long flame hot air burner. However, in 1943 another type product was developed when the constant flow valve was introduced. The tempered flame burner was introduced in 1944, and in 1947 the Bloom Paulsen-Steinbart blast furnace gas burner and time cycle reversal unit were added to the line. A valuable product for furnace support pipe insulation called Ka-Weld was introduced in 1948, and in 1949 the baffle burner was developed. Since then in 1950 the high-thermal release burner for gas or oil was developed, and in 1952 the low pressure air atomizing oil burner. The future should bring many more developments.

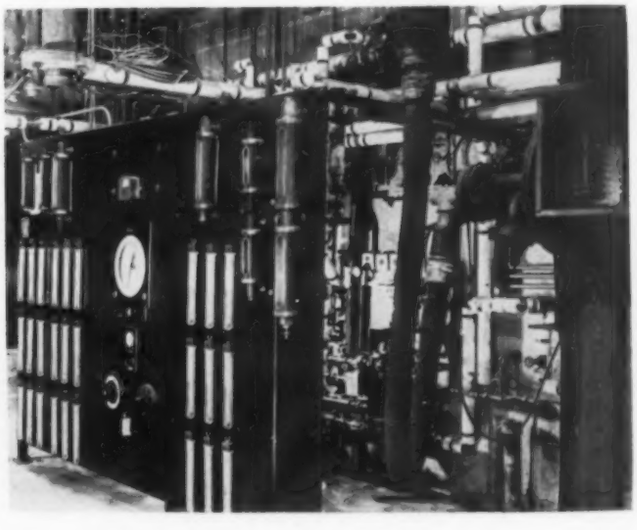
The addition of these new lines in the development of this new equipment necessarily resulted in additional requirements for engineering and manufacturing facilities. Therefore, the company was moved to larger quarters at West North Ave. in 1939. An expansion program in 1947 added a single story building next to the office, and 1950 a second floor was added. The building program was finally completed this year. The company now employs 60 employees.

The new facilities give enlarged office space for the engineering-sales department, production department and drawing room. In addition, a shop has been provided on the first floor with plentiful assembly and storage space and a modern machine shop and test laboratory are also included in the building. Of particular value to Bloom customers is the test laboratory which provides space and

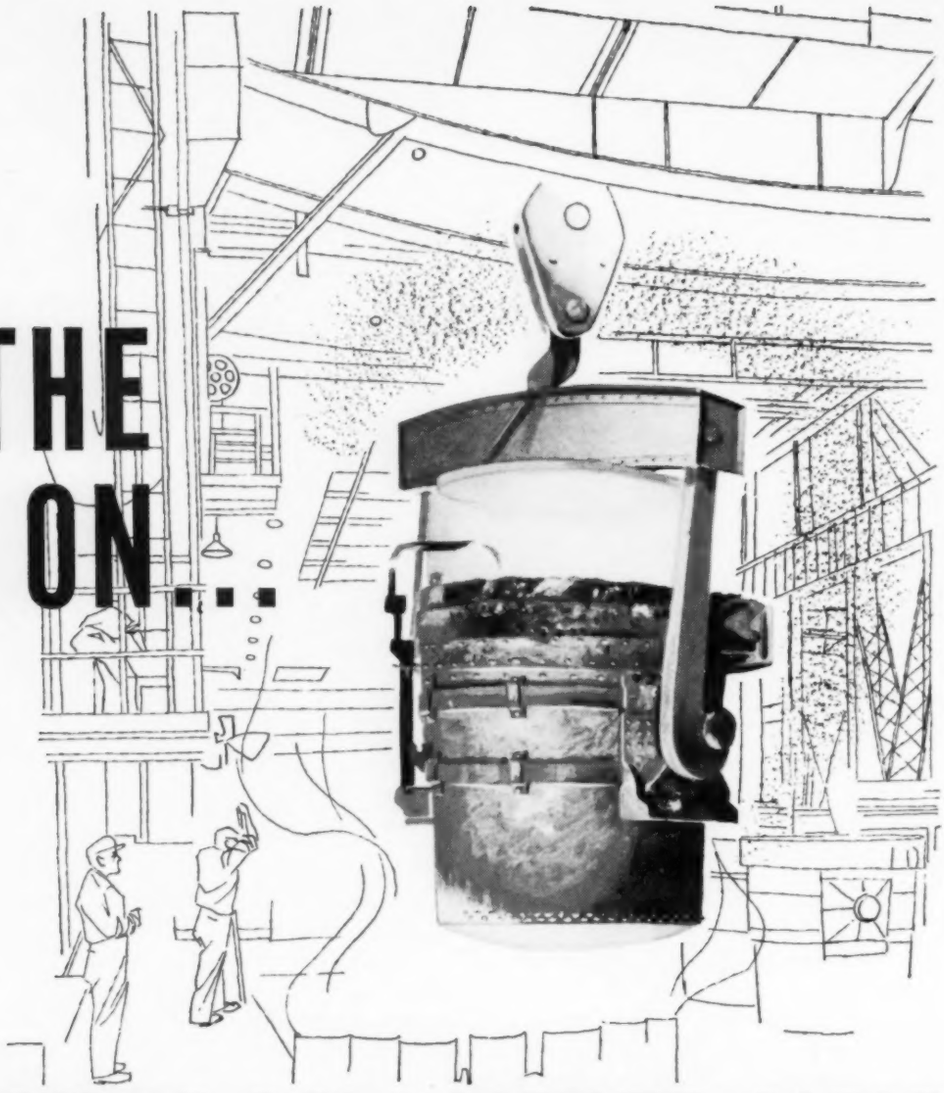
In this laboratory furnace, burners can be observed under actual operating conditions. Conditions can also be varied at will to obtain accurate data.



Equipment on furnace control panel gives an idea of the wide variety of conditions that can be controlled, measured and observed on the laboratory furnace.



WHEN THE HEAT'S ON...



IT'S ROCKBESTOS A.V.C. POWER CABLE

This "sandwich" protects the varnish cambric. It enables A.V.C. to carry more current than cables with conventional insulations.
Inner Felted Asbestos Wall
Varnished Cambric
Outer Felted Asbestos Wall

FOR KEEPING COSTS DOWN!

Steel Mill and Foundry "hot spots" provide one of the world's worst torture chambers for wire and cable. Heat, steam and corrosive fumes combine to kill *ordinary* cable quickly.

To keep costs down and current dependably flowing, use Rockbestos A.V.C. Cable in all circuits . . . especially "hot spots."

Permanently insulated Rockbestos A.V.C. takes temperatures up to 230°F. Even severe heat or flame won't crack, blister or burn it.

What's more, Rockbestos A.V.C. won't bloom or rot when exposed to oil, grease or corrosive fumes.

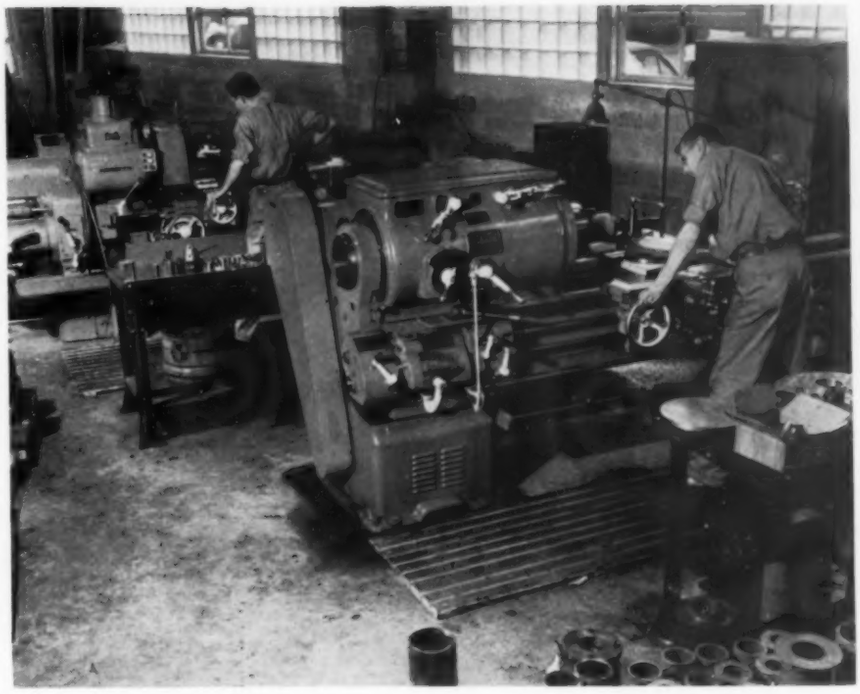
Built to beat the heat, Rockbestos A.V.C. reduces maintenance and operating costs . . . gives you years more dependable service. Plan now to avoid future "hot spot" failures and expense — install Rockbestos A.V.C.

ROCKBESTOS PRODUCTS CORP.
NEW HAVEN 4, CONNECTICUT
the originators of **A. V. C.®**

New York • Cleveland • Detroit • Chicago • Pittsburgh • St. Louis
New Orleans • Los Angeles • Seattle • Oakland, California

equipment for the development of products. This laboratory has furnaces and equipment with which burners can be observed under actual operating conditions, and thus the company can develop new burners or obtain data on heat transfer problems. This work also gives data which indicates how better furnaces and burners can be built. The laboratory is equipped with high pressure boiler installation, light and heavy oil storage tanks and pumping systems, fans and compressors for obtaining all the necessary conditions for furnace and burner operation. Gas, oil, steam and air can be accurately measured and controlled through a large control panel which is permanently installed.

All Bloom equipment is engineered to satisfy the requirements of the basic steel industry, and a complete line of specialized furnace equipment is manufactured for each step in the steelmaking process from the blast furnace through the finishing processes. In addition, products are also manufactured for special uses in the glass, refractory, chemical and papermaking industries. Some equipment has also been made for ordnance purposes. Although material first sold consisted primarily of burners, it was quickly recognized that the furnace design, the combustion system and the burner location were just as important in the final result as the burner itself. For this reason the company has made a policy of engineering each application. This requires also checking of performance, operation and requirements both before and after installation. This has resulted in improved operation and economy for the customer.



Critical manufacturing operations are performed within the Bloom plant.

The corporate structure of Bloom Engineering Co. changed also with time, and in 1948 it changed from a sole proprietorship to a corporation with Fred S. Bloom as president. This was done in order to better serve the customer and employees by insuring continuity of management and increased facilities. The corporation and the directors are so set up as to maintain a very close employee-employer relationship. Every effort is made to foster the spirit of cooperation between employee and employer, and both have a mutual desire to play their part in the forward progress of the company.

The Bloom time-cycle reversal unit for regenerative furnaces automatically initiates all operations for uniform reversal on a predetermined time cycle.

Bloom constant flow oil valves are precision made and carefully checked for accurate performance before shipment.

Applications for AISE Membership

Active

ROBERT E. ALDSTADT
Roll Designer
Republic Steel Corp.
Cleveland, Ohio.

MAX C. AMEN
Supervisor
Ford Motor Co.
Dearborn, Mich.

H. L. ANDERSON
Ceramic Engineer
Republic Steel Corp.
Warren, Ohio.

JOHN M. BATCHO
Technical Assistant (Electrical Dept.)
Wheeling Steel Corp.
Steubenville, Ohio.

MAX E. BILIS
Assistant Superintendent, 80-Inch Hot Strip Department
Gary Sheet and Tin Mill
United States Steel Co.
Gary, Ind.

ALLAN BOETTGER
Supervisor Steel Mill Scheduling Department
Ford Motor Co.
Steel Division
Dearborn, Mich.

CARL E. BREHMER
General Electrical Foreman — Tin Mill
Inland Steel Co.
East Chicago, Ind.

PAUL P. CHAPLA
Superintendent, Finishing, Stocking and Shipping
National Tube Division
Fairless Works
United States Steel Co.
Bucks County, Pa.

SILAS CLINE
Assistant Superintendent, Mechanical Maintenance
Allegheny Ludlum Steel Corp.
Dunkirk, N. Y.

HAROLD J. COOPER
Foreman — Open Hearth
Steel Division
Ford Motor Co.
Dearborn, Mich.

ANTHONY F. DEAN
Design Engineer
United States Steel Co.
Pittsburgh, Pa.

JAMES H. DICKERSON
Assistant Superintendent, Maintenance
United States Steel Co.
Gary Sheet & Tin Mill
Gary, Ind.

ARTHUR DICKSON
Blooming Mill Roller
Compania de Acero Del Pacifico, S. A.
Casilla i-C
Talcahuano, Chile.

D. A. EDGECOMBE
Assistant Superintendent, Extrusion Department
Babcock & Wilcox Co.
Beaver Falls, Pa.

GEORGE FINDLAY
Lubrication Engineer
Republic Steel Corp.
Buffalo, N. Y.

FRANK EDWARD GILMORE
Temper Mill Roller
Kaiser Steel Corp.
Fontana, Calif.

GEORGE K. GOALEN
General Foreman — Blooming and Billet Mills
Ford Motor Co.
Steel Division
Dearborn, Mich.

THEO. H. HARLEY
Refractories Engineer
Ford Motor Co.
Rouge Plant
Dearborn, Mich.

CHARLES J. HUNTER
Assistant General Superintendent
Gary Steel Works
United States Steel Co.
Gary, Ind.

W. E. JOHNSON
Works Manager
Phoenix Manufacturing Co.
Joliet, Ill.

A. R. KERTH
Chief Engineer
Wickwire Spencer Steel Division
Buffalo, N. Y.

JOSEPH P. LENCIONI
Superintendent of Cold Rolling Mill
Kaiser Steel Corp.
Fontana, Calif.

JOHN W. LOHSE
Assistant Superintendent Maintenance
United States Steel Co.
Gary Sheet & Tin Mill
Gary, Ind.

ROBERT A. McINTOSH
Special Engineer
Bethlehem Steel Co.
Bethlehem, Pa.

BERTRAM D. McMILLEN, JR.
Contract and Specification Engineer
United States Steel Co.
Pittsburgh, Pa.

ROBERT BURTON MAXWELL
Shift, Foreman, Stainless Steel Sheet Mill
Atlas Steels, Ltd.
Welland, Ontario, Canada

J. G. MITCHELL
Ass't. Superintendent (Electrical Department)
The Steel Company of Canada, Ltd.
Hamilton, Ontario, Canada

FRANK NONEMAKER, JR.
Plant Engineer
Boiardi Steel Corp.
Milton, Pa.

CHARLES A. O'MALLEY
Metallurgical Engineer
Ford Motor Co.
Steel Division
Dearborn, Mich.

OLEN N. OPDYKE
Manager — Production Control
Ford Motor Co.
Steel Division
Dearborn, Mich.

J. P. PEACOCK, JR.
Assistant to Chief Engineer
Bethlehem Steel Co.
Sparrows Point, Md.

JAMES W. PURDY
General Foreman — Merchant Bar Mills — Steel Division
Ford Motor Co.
Dearborn, Mich.

JOSEPH A. RANSEL
Assistant Division Superintendent Maintenance
United States Steel Co.
Gary Steel Works
Gary, Ind.

W. H. RICHEY
Strip Mill Metallurgist
Jones & Laughlin Steel Corp.
Pittsburgh, Pa.

BERNARD ROBERTS
Relief Turn Foreman
Wheeling Steel Corp.
Yorkville, Ohio

ROBERT D. ROMERIL
Looper
Bethlehem Steel Co.
Sparrows Point, Md.

CHARLES M. SHANK
Division Superintendent Maintenance and Utilities
Gary Sheet & Tin Mill
United States Steel Co.
Gary, Ind.

NORMAN C. STROTH
Assistant Electrical Maintenance Superintendent
Allegheny Ludlum Steel Corp.
Dunkirk, N. Y.

CLAYTON O. SYLVESTER
General Foreman
Wickwire Spencer Steel Division
Colorado Fuel & Iron Corp.
Buffalo, N. Y.

EUGENE S. THORPE
Boiler House Superintendent
Hanna Furnace Corp.
Buffalo, N. Y.

JAMES E. TRABITS
Mechanical Maintenance Superintendent
Allegheny Ludlum Steel Corp.
Dunkirk, N. Y.

WARD E. WARREN
Chief Industrial Engineer
Brainard Steel Division of Sharonsteel
Warren, Ohio

LEW C. WHEELAND
Electrical Engineer
Construction Engineering Department
National Tube Division
United States Steel Co.
Lorain, Ohio.

EVAN I. WILLIAMS
Superintendent Steel Shipping
Ford Motor Co.
Steel Division
Dearborn, Mich.

JAMES A. YOUNG
Design Engineer
Kaiser Engineers Division
Henry J. Kaiser Co.
Oakland, Calif.

Associate

JOHN ALICO
Project Engineer
Lake Erie Engineering Corp.
Buffalo, N. Y.

L. P. ANDERSON
Sales Engineer
E. W. Bliss Co.
Salem, Ohio

THOMAS J. BARTHLOW
Sales Engineer
Hagan Corp.
Buffalo, N. Y.

R. H. BENNEWITZ
Assistant District Manager
Linde Air Products Co.
Detroit, Mich.

P. H. BOONE
Sales Manager
Bearing Service Co.
Pittsburgh, Pa.

JOHN O. BROWN
Switchgear Application Engineer
Jos. W. Eshelman & Co., Inc.
Birmingham, Ala.

GLENN O. CARTER
Partner
Percival R. Moses & Associates
New York, N. Y.

CALEB DAVIES
Engineer
North American Manufacturing Co.
Chicago, Ill.

RALPH J. DAVIS
Manufacturers Representative
Chicago, Ill.

CHARLES R. EYER
Field Engineer
H. H. Robertson Co.
Buffalo, N. Y.

SAMUEL FRIEDLANDER
Project Engineer
Wean Equipment Corp.
Cleveland, Ohio

ROBERT L. FULLER
Design Engineer
Freyn Division
Koppers Co., Inc.
Chicago, Ill.

D. W. GAMES
Project Engineer
Wean Equipment Corp.
Cleveland, Ohio

R. JOHN GESS
Vice President — Charge of Manufacturing
Lake Erie Engineering Corp.
Buffalo, N. Y.

C. M. GOODRICH
Sales Representative
U. S. Graphite Co.
Northville, Mich.

ROLAND W. GRAFF
Field Engineer
National Aluminate Corp.
Chicago, Ill.

Are you acquainted with this type of HYATT bearing?

Here is the Industrial Inch 70,000 Series three-part Hyatt Roller Bearing designed for large diameter, slow speed shafts in heavy equipment where fractional dimensions are the rule.

The races are made from alloy steel forgings which are heat-treated to obtain the greatest possible strength and durability, then finish-ground to close tolerances. The roller assembly is made up of two bronze end rings drilled to pocket the roller ends and riveted to steel spacing bars.

Built to fulfill specific requirements, this Industrial Inch Bearing, like all the other Hyatt Bearings employing solid or wound rollers, is proving most satisfactory for its particular application.

* * *

Write for Catalog No. 150 for further details in the Inch Series and all the other popular Hyatts for all your bearing needs. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

STEEL MILL GAS WASHERS CLEANED WITHOUT SHUT-DOWN

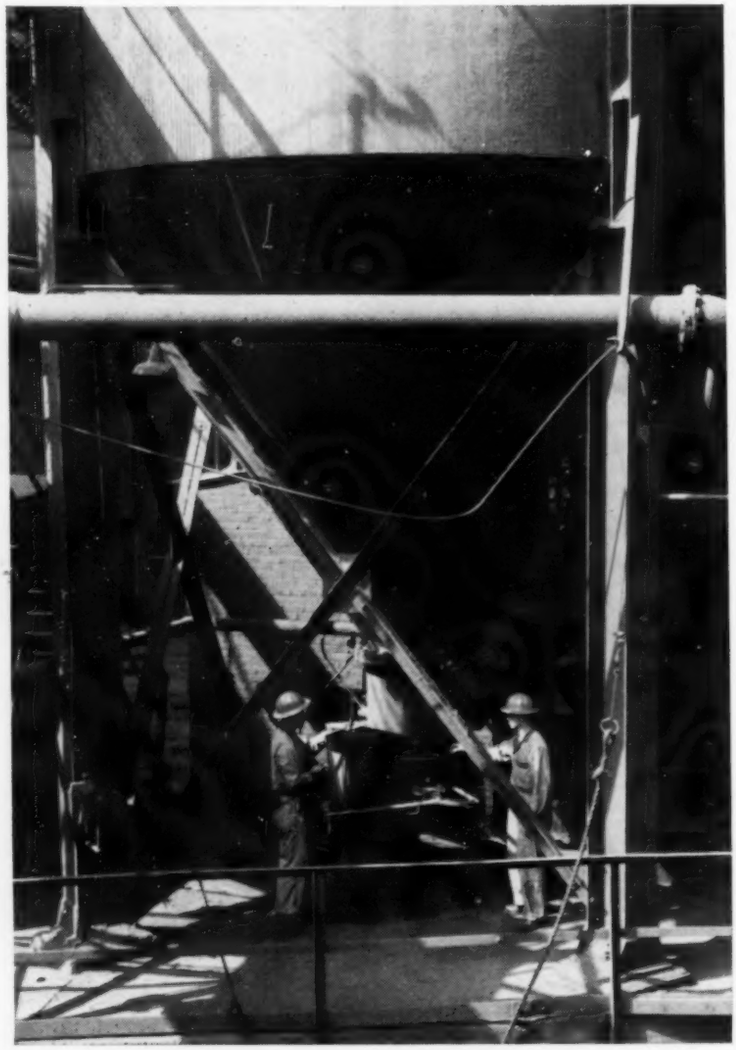
Cleaning with Chemicals by Dowell Service Saves Costly Dismantling and Downtime

Here's a comparative case history that points out the advantages of Dowell Service over mechanical cleaning methods.

The blast furnace to be serviced had three gas washers which needed cleaning. One of these was cleaned mechanically. The other two were cleaned with chemicals by Dowell Service.

The mechanical cleaning took three days time and required 768 man hours. The remaining two washers were cleaned simultaneously by Dowell Service *in just four hours* . . . without interrupting washing operations or reducing blast furnace wind.

With specially-designed Dowell pump trucks and control equipment, experienced Dowell engineers can give you fast cleaning service. Many pieces of equipment can be cleaned while in operation.



Free Bulletin on Chemical Cleaning for Steel Mill Equipment

For your convenience, we have prepared an informative bulletin that tells you about the chemical cleaning of many different kinds of steel mill equipment by Dowell Service. For your free copy, write today to Dept. 229, Tulsa, Okla.

DOWELL SERVICE

Over 90 Offices to Serve You with Maintenance Cleaning for:

Boilers • Condensers • Heat Exchangers • Gas Mains
Stoves • Furnace Cooling Systems • Piping Systems • Gas Washers • Process Towers • Ammonia Scrubbers • Precipitators

Chemical Services for Oil, Gas and Water Wells

DOWELL INCORPORATED
Tulsa 1, Oklahoma

DOWELL

A Service Subsidiary of
THE DOW CHEMICAL COMPANY

Date-line Diary...

November 3

▲ The Labor Department reported employment in manufacturing for September was the highest since World War II.

▲ Based on reports from companies having 93 per cent of capacity for the steel industry, the operating rate for the week beginning November 3rd is scheduled at 105.7 per cent of capacity. This is equivalent to 2,196,000 tons of steel ingots and castings compared with 2,229,000 when the furnaces operated at an average of 107.3 per cent of capacity one week ago.

November 4

▲ According to the AISI, an average of $2.139 an hr was paid in August to wage earners in the iron and steel industry. Total employment in August was estimated at 659,800, and the average work week for this month was 28.2 hr.

▲ The Commerce Department reports that unemployment in October dropped to 1,284,000 from 1,438,000 in September. The total number of people employed in October were 61,862,000.

▲ The price of lead increased ½¢ to 14¢ a lb in New York and increased to 13.80¢ a lb in East St. Louis.

November 5

▲ Commerce Department reported that personal income in September reached an annual rate of $273,000,000,000, or $16,000,000,000 above September 1952.

▲ The Commerce and Labor Departments reported that for the first ten months of 1952, construction outlays rose to $27,000,000,000, or 4 per cent above the same period in 1951.

▲ The DPA reduced its goal 85,000 tons for expansion of zinc capacity because it was out of line with reasonable estimates for the demand of this metal. This is a 33 per cent reduction in the goal previously set up.

▲ Iron ore shipments on the Great Lakes to date totaled 66,000,000 tons compared with 83,000,000 tons for the same period last year. At this rate the goal of 75,000,000 tons set for 1952 will probably not be met.

November 6

▲ Canadian output of steel ingots amounted to 277,684 in September or 8 per cent higher than the like period in 1951.

▲ The NPA abolished sulphur controls.

▲ The DPA approved distribution of an additional 1,480,000 tons of carbon steel products to meet the industry's demand for first quarter 1953 steel including an additional 336,950 tons of steel for auto makers.

November 7

▲ United States Steel Corp. announced that a record of 3,195,761 tons of ingots were produced in October.

▲ The Soho furnaces of Jones & Laughlin Steel Corp. which have been producing about 15,000 tons of steel monthly have been temporarily closed down.

▲ Britain's Tories published their bill for denationalizing the steel industry.

▲ The Aluminum Association reports production of primary aluminum in September totaled 153,764,606 lb, or an increase of 18 per cent over the same month in 1951. Shipments of aluminum sheet and plate totaled 94,442,980 lb in September, compared with 91,094,081 lb in August.

November 10

▲ Canada's exchange rate which reached a high of $1.04-5/16 in August is currently quoted at $1.0287.

▲ Based on reports of companies having 93 per cent capacity of the steel industry, the operating rate of the industry for the week beginning November 10, 1952 is scheduled at 106.4 per cent of capacity. This is equivalent to 2,209,000 tons of steel ingots and castings compared with 2,200,000 tons one week ago.

November 11

▲ According to the American Railway Car Institute, deliveries of new domestic freight cars in October totaled 5437 compared with 3762 in September. Orders in October totaled 1423 and the backlog of cars on order as of November 1, was 90,708.

November 12

▲ At the Gary Works of United States Steel Co. plans are being made to dismantle and rebuild two of the 16 coke oven batteries. The rebuilding project will take approximately one year and each new battery will contain 77 coke ovens.

▲ The NPA eased inventory restrictions on steel, copper and aluminum.

November 13

▲ Export quota for carbon steel, not including tinplate for the first quarter of 1953, is 390,780 tons, or 175,000 tons less than fourth quarter allotments.

▲ At the Mystic Iron Works, Everett, Mass., production has stopped due to a hearth breakout which has shut down blast furnace operations.

▲ St. Joseph Lead Co. boosted the price of lead 30 points to 14.50¢ a lb in New York and 14.30¢ a lb in St. Louis.

▲ The Commerce Department reported that dividend payments of United States corporations in the first ten months of 1952 totaled $6,300,000,000, or a 3 per cent increase over the same period in 1951.

▲ A freight service improvement program amounting to $47,000,000 has been announced by the Pennsylvania Railroad, which will result in faster freight schedules.

November 14

▲ A battery of 29 new coke ovens have been put in operation at the Midland Works of Crucible Steel Co. which will increase its coking production to 832,000 tons.

November 15

▲ The Commerce Department reported that U. S. exports in September amounted to $1,217,300,000, off 3 per cent from the 1951 rate for the same period. U. S. imports were valued at $877,000,000 or a 20 per cent increase over the same period in 1951.

▲ The United States nickel expansion goal has been stepped up by the DPA for a total supply of 190,000 tons in 1955, about three times the size of the original expansion program set in February.

▲ Great Lakes shipping companies were denied

higher rates for carrying iron ore, limestone and coal by Price Stabilizer Woods.

▲ According to Ward's automotive Reports, to date in 1952, auto assemblies have totaled 3,730,800 units or a 23 per cent drop for the same period in 1951.

November 17

▲ In a joint report, the Securities and Exchange Commission and the Federal Trade Commission estimated manufacturing firms net profits in the second quarter of 1952 were $2,600,000,000, the same as the first quarter, but off 20 per cent from the second quarter in 1951. Sales totaled $61,400,000,000 in the second quarter compared with $60,600,000,000 in the first quarter of 1952.

▲ Based on reports from companies having 93 per cent capacity for the steel industry, the operating rate for the week beginning November 17th is scheduled at 106.1 per cent of capacity. This is equivalent to 2,203,000 tons of steel ingots and castings for the industry compared with 2,215,000 tons one week ago.

November 18

▲ The Commerce Department reported that national production of goods and services during the third quarter of 1952 rose to an annual rate of $343,400,000,000, or $800,000,000 above the second quarter.

▲ At the public hearing before Economic Stabilizer Putnam, John L. Lewis and Harry M. Moses, urged reversal of the Wage Stabilization Board's ruling to lop off 40¢ from the $1.90 pay hike agreed on by the soft coal producers and the union.

▲ Copperweld Steel Co. of Pittsburgh has offered approximately $8,650,000 for all the outstanding common stock of the Ohio Seamless Tube Co. of Shelby, Ohio.

November 19

▲ The Ernest T. Weir, the newest ore freighter of National Steel Corp., was launched today. This 690-ft long vessel is the largest bulk carrier on the Great Lakes.

November 20

▲ The DPA granted quick tax write-offs to Olin Industries, Inc., East Alton, Ill. on a proposed $168,000,000 aluminum project. The company plans to spend $45,000,000 for a sheet, plate and extrusion plant, and $123,000,000 for primary aluminum producing facilities.

November 21

▲ For a meeting on November 24, the steel companies presented a plan to the NPA for decontrolling steel supplies.

▲ The price of lead dropped ¼¢ to 14¼¢ a lb in New York.

▲ A special meeting of stockholders of the Blaw-Knox Co. has been called for December 15 to vote on a plan to merge the company with its operating subsidiaries.

November 22

▲ The Federal Reserve Board estimated 1952 output of goods and services at $345,000,000,000, up 5 per cent from 1951.

▲ OPS authorized coke and coal chemical manufacturers to raise ceiling prices 3.75 per cent.

November 24

▲ The Barium Steel Corp. has purchased a rotary forging seamless tube mill from Pittsburgh Steel Co. to be installed at Phoenixville, Pa. The new mill will produce 180,000 tons of 5½ to 13⅜-in. diam oil well casing and heavy wall pressure tubing in lengths up to 60 ft.

▲ Based on reports from companies having 93 per cent of capacity for the steel industry, the operating rate for the week beginning November 24 is scheduled at 105.5 per cent of capacity. This is equivalent to 2,191,000 tons of steel ingots and castings compared with 2,212,000 tons one week ago.

▲ The Commerce Department reported that for the past 12 years U. S. foreign aid of all types totaled $87,400,000,000,000.

▲ In the third quarter of 1952 corporate earnings of 727 companies were 5.2 per cent above the same period of 1951.

November 25

▲ According to the AISI, in September average earnings in the iron and steel industry were $2.206 per hr compared with $2.139 in August. Wage earners worked an average of 40.3 hr a week in September compared with 38.2 hr per week in August. Total employment for the month was estimated at 673,600 compared with the August total of 659,800.

▲ Price of lead dropped ¼¢ to 14¢ a lb in New York.

November 26

▲ For the fiscal year starting July 1, 1953, Defense Mobilizer Fowler announced that Congress will be asked to allocate funds to set up a standby reserve of machine tools to be ready for use in the event of an all out war.

▲ Clifford F. Hood has been elected president of United States Steel Corp. succeeding Benjamin F. Fairless, who will continue as chairman and chief executive officer.

▲ F. W. Dodge Corp. announced that construction contracts for the first 10 months in the thirty-seven states east of the Rockies totaled $14,048,749,000 compared with $13,585,024,000 for the same period a year ago.

▲ According to the AISC, shipments of fabricated structural steel in October amounted to 258,535 tons, or a 14 per cent increase over September. For the first ten months of 1952 total shipments amounted to 2,211,237 tons. During October total bookings were 184,711 tons, or 11 per cent less than September. As of October 31 backlog stands at 2,266,875 tons.

November 27

▲ A battery of 76-by-product coke ovens will be constructed at Youngstown Sheet & Tube Co.'s Campbell works. The contract for this construction has been awarded to Wilputte Coke Oven Division of Allied Chemical & Die Corp., and these facilities will have a rated capacity of 450,000 tons per year.

November 29

▲ The Commerce and Labor Departments forecast that new construction expenditures in 1953 will rise $1,200,000,000 over the $32,300,000,000 in 1952.

▲ The Commerce Department reports that job holders numbered 62,228,000 in early November, or 1,000,000 higher than for the same period of 1951.

▲ A new furnace which will have a capacity of 1350 tons a day will be built at the Central Furnace and Docks plant of American Steel & Wire Division of United States Steel Corp. It is expected to be in operation early in 1954.

▲ At Indianapolis, Ind., the Cold Metal Products Co. of Youngstown have started construction of an estimated $4,000,000 plant, which will manufacture rolled steel products and is scheduled for completion early in 1954.

November 30

▲ The International Materials Conference announced that cobalt allocations to free-world consumers will not be made for the first quarter of 1953, because of improved supply.

FOR STEEL PLANT EQUIPMENT

DRIVE MOTORS • MILL MACHINERY • CRANES • AUXILIARY EQUIPMENT and COMPONENT PARTS FOR ALL MILLS

No need to let delayed deliveries of new steel plant equipment stall your production schedules. We can supply good used equipment. . . NOW . . . at substantial savings in cost! We also provide dependable service on engineering and installation of accessories. It pays to *Call Curry* for complete rolling mills, motors, press brakes, roll grinders, ladles, cranes and other equipment you need *in a hurry*.

Check the partial list of equipment below—available for immediate delivery. Write, wire or phone today for the complete "Curry List" of equipment we now have which may answer your requirements.

2½" & 20" x 7½" REVERSING COLD REDUCTION STECKEL MILL, complete with Recoiling Equipment, Main Drive Motor, Motor-Generator Set, Controls and Spare Parts.

75-TON MORGAN LADLE CRANE. WITH 25-TON AUXILIARY. 4-Girder Construction. Span 49'6". Motors & Controls for 230v. DC operation.

18"/21" 3-HIGH BAR MILL, complete with Pinion Stand, Gear Reduction Unit, 2500 H.P. Motor, Billet Heating Furnace, Tables and Electric Equipment.

2000 H.P., G.E. SLIP RING MILL TYPE MOTOR, 3/60/2300 v 237 RPM, complete with Liquid Slip Regulator and all controls necessary for mill type operation, including Filtered Air Cooling System.

NO. 2 CANTON ALLIGATOR SHEAR. 21" Knives. Capacity 2" Rounds. Including 5 H.P. Motor 3/60/220v.

500 H.P. FALK GEAR REDUCTION UNIT. Ratio 18.6 to 1, for 31 RPM output.

Write for the Curry List today!

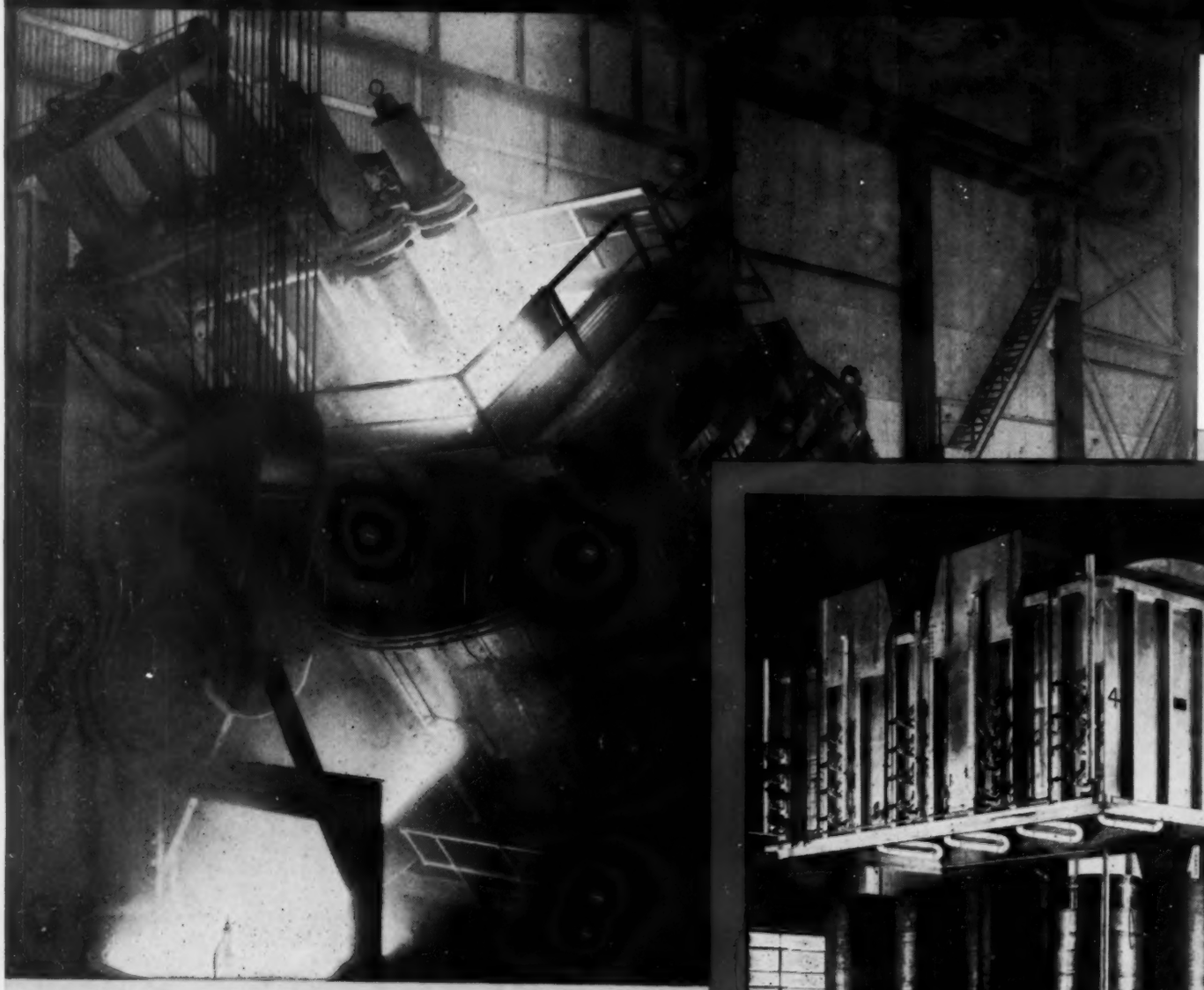
ALBERT Curry & CO., INC.

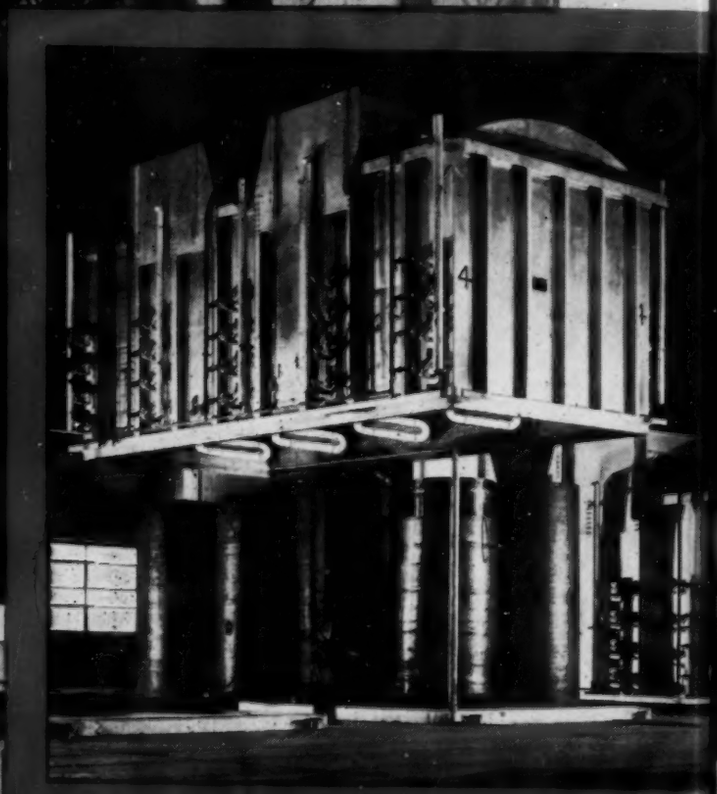
STEEL PLANT EQUIPMENT

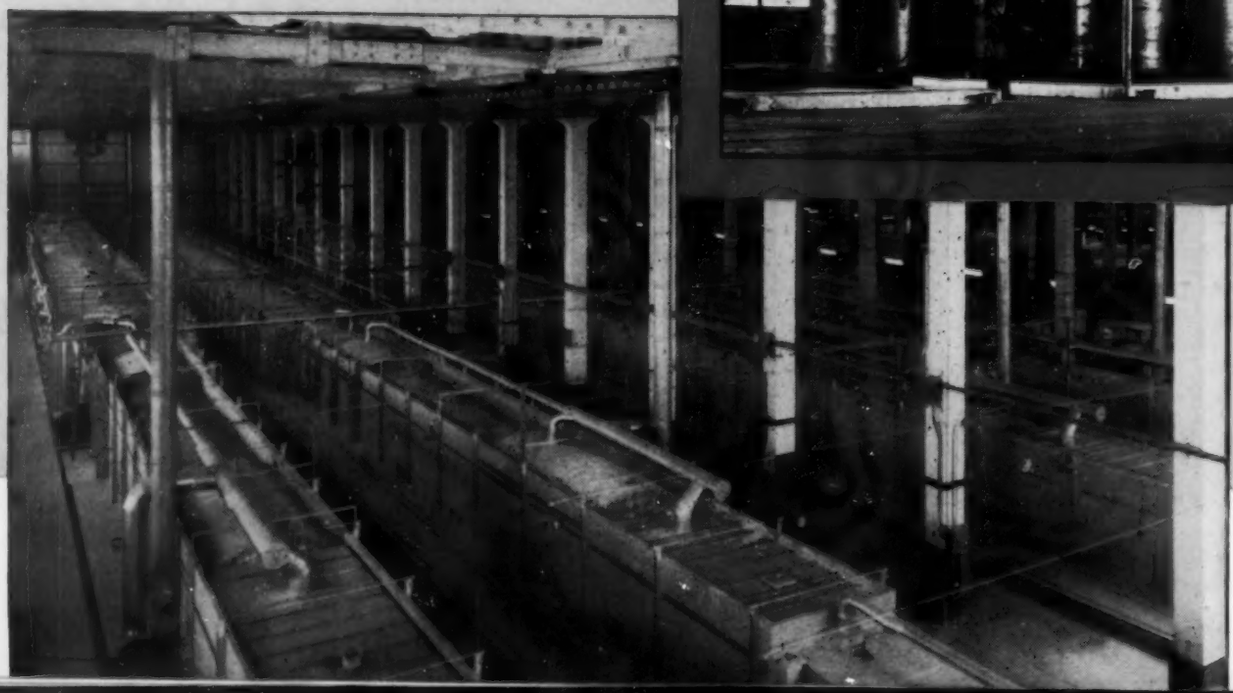
Cable Address — Curmill Pittsburgh

940 OLIVER BUILDING • PHONE ATLANTIC 1-1370

SWINDELL-DRESSLER

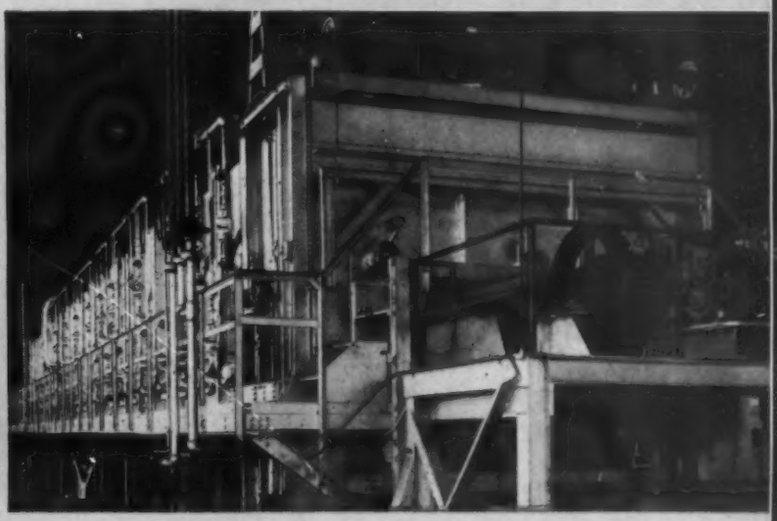






Industrial Furnaces

Effectively Aiding
GREATER PRODUCTION of
Metals and Ceramics Essential
to the National Defense Program



SWINDELL-DRESSLER *Corporation*

DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH 30, PA.

TASIL IS TAYLOR-MADE FOR MIXERS!

TASIL LASTS TWO CAMPAIGNS

THE FIRST CAMPAIGN: Taylor Sillimanite (TASIL) brick laid in TASIL No. 302 Heat-Setting Cement was used to strengthen the vulnerable areas of the lining of a 1300 ton Hot Metal Mixer which began operation in June, 1950. In April, 1951, after approximately 450,000 tons had been through the mixer, the TASIL brick in the front and backwall were in such excellent condition—having lost only 2 to 2½ inches—that they were left in for a second campaign, while most sections of fireclay brick had to be replaced.

THE SECOND CAMPAIGN: From April to December, 1951. Handled approximately 377,000 additional tons. Condition of TASIL at end of *two* campaigns is shown in lower half of the above photograph.

TOTAL FOR TWO CAMPAIGNS: *18 months service, approximately 827,000 tons handled.*

This contrasts with a five-campaign average of 225,000 tons for Blast Furnace Quality Firebrick linings in this mixer.

Results such as this continue to prove that TASIL "Balanced" linings are unsurpassed, from the standpoint of over-all life and economy. Use TASIL Brick in the areas of severe erosion—fireclay or super-duty brick in the remainder of the lining—*all* laid in TASIL Cement. Call in a Taylor representative for a factual discussion of TASIL possibilities in your mixers, ladles and hot metal cars.

Exclusive Agents in Canada:
REFRACTORIES ENGINEERING AND SUPPLIES, LTD.
Hamilton and Montreal

TAYLOR ZIRCON · TAYLOR SILLIMANITE

The **CHAS. TAYLOR SONS Co.**
A SUBSIDIARY OF NATIONAL LEAD COMPANY
REG. U. S. PAT. OFF.
REFRACTORIES SINCE 1864 • CINCINNATI • OHIO • U. S. A.

CRANES . . . FOR THE STEEL MILL

When your Steel Mill Cranes are "Shaw-Box", they are built with an intimate understanding of mill requirements, gained through years of working closely with the steel industry. Manufactured to exacting standards of fine engineering and precision workmanship, each one stands out as an example of the interpretation that can be made of individual mill or AISE specifications. Simple, rugged, and extremely accessible, they include the extra values of advanced design and construction excellence for which "Shaw-Box" Steel Mill Cranes are known and recognized throughout the industry. The plus advantages of "Shaw-Box" experience and precision manufacturing methods insure you trouble-free operation and dependability, with minimum maintenance costs, under the most severe operating conditions.

For the greatest value in dependably superior crane service you can buy, look to "Shaw-Box".

BE SURE TO SEND ALL YOUR INQUIRIES FOR STEEL MILL CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

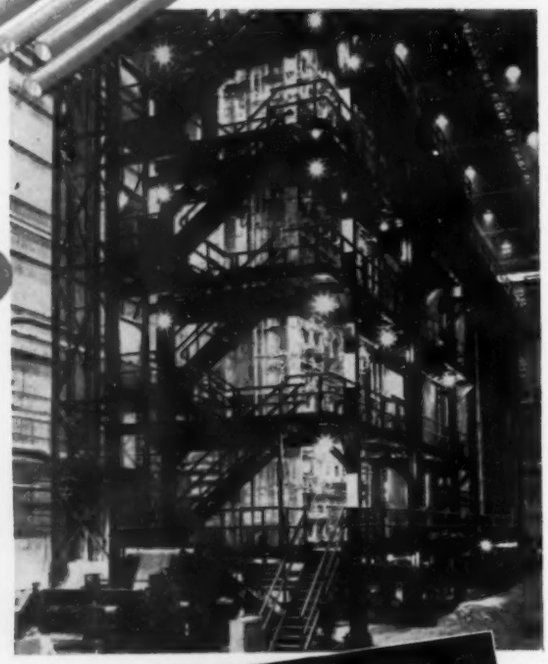
Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, and 'American' Industrial Instruments.

Improved product

Reduced finishing costs

Greater customer acceptance

Finished steel quality control is the goal of every Steel Maker. Steel finishing under precise atmosphere control is the answer. It assures premium quality at lower ultimate cost. Some applications of these "Surface" generators are described below.



BRIGHT ANNEALING, STRIP

1 — *Continuous bright annealing of strip*, for tin plating, is carried out at high speeds in this vertical strand furnace. NX or HNX atmosphere can be used.

2 — *Batch bright annealing of coiled strip* is accomplished in lift cover furnaces of the type shown. In this single row installation, NX protective atmosphere is used.

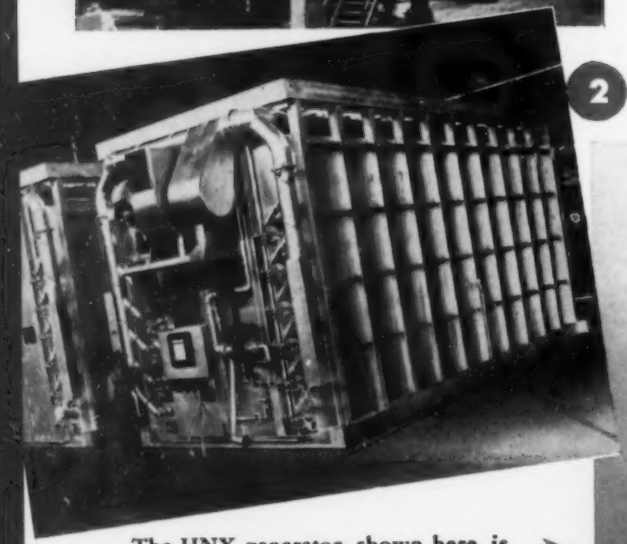
CARBON CORRECTION, BAR STOCK

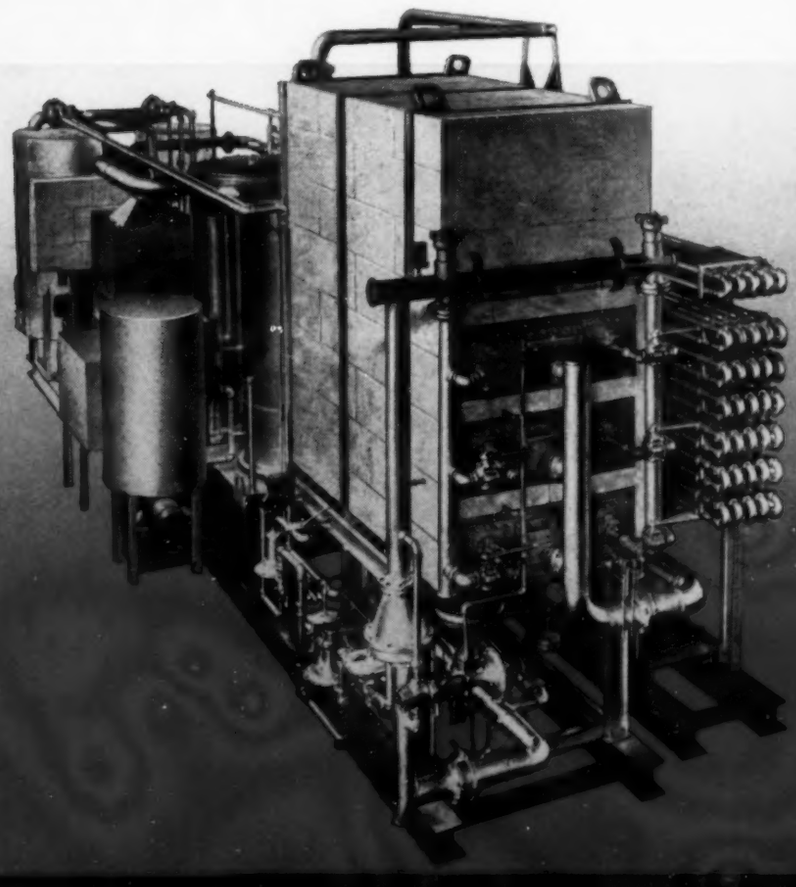
3 — *Batch carbon restoration* utilizes this lift cover, carbottom type furnace for simultaneous skin recovery and clean annealing. Here again, the reactive carbon medium is enriched RX atmosphere and the protective medium is NX atmosphere.

4 — *Continuous production carbon restoration of bar stock* is accomplished in this roller hearth furnace in conjunction with clean annealing. Enriched, RX atmosphere, is used as the carburizing medium and NX atmosphere for surface protection.

BRIGHT ANNEALING, SHEET

5 — *Continuous bright annealing of stainless clad sheet* in this disc hearth furnace with special rapid air quench chamber utilizes a protective atmosphere of DX gas.



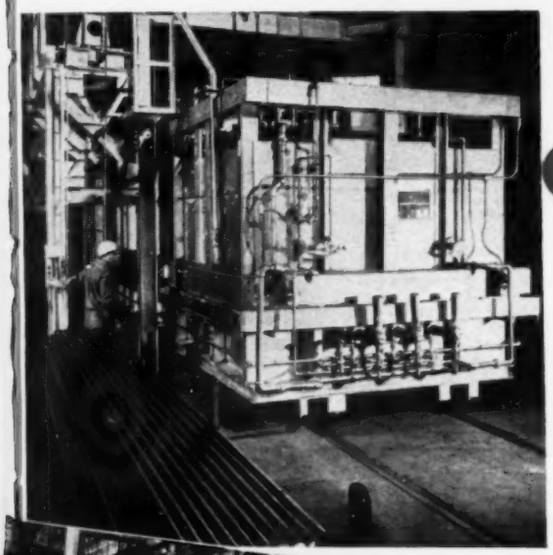


The HNX generator, shown here, is one of the five principal atmosphere generator types—RX, DX, NX, AX—built by Surface Combustion. They represent the engineering skill and 'know how' of 40 years standing in serving the nation's steelmakers. They make finished quality steel a practicality.

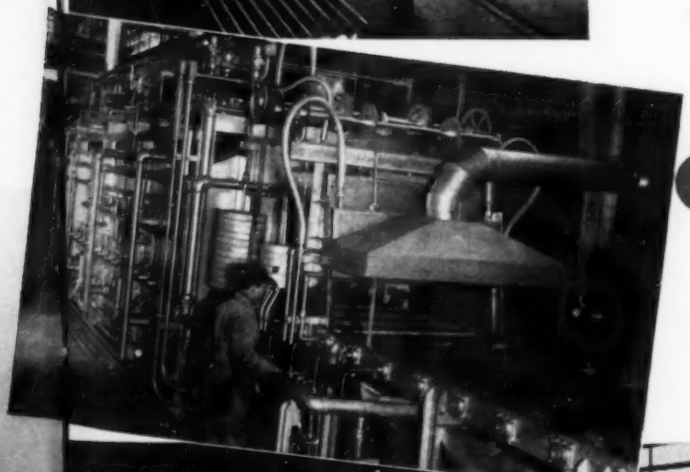
For complete information on the applications of these atmospheres, write for Bulletin SC-155.

YOU GET ALL 3 WITH *Surface*

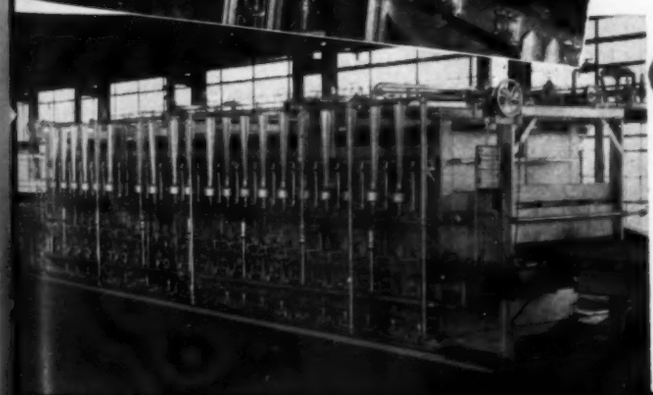
CONTROLLED ATMOSPHERE



3



4



5

FURNACES AND GENERATORS

Controlled atmospheres have opened up endless possibilities throughout the Steel Industry for the safeguarding of product quality and increasing customer acceptance. Case carburizing...dry cyaniding... homogeneous carburizing . . . carbon restoration . . . clean hardening . . . bright or clean annealing . . . galvanizing . . . are among the important finishing operations, which come under its influence. These can be accomplished faster and with far better results using controlled atmospheres than by direct heating methods.

'*Surface*' has contributed materially to the success of controlled atmosphere in the Steel Industry. '*Surface*' Furnaces and Generators have given controlled atmosphere processes full production status at a time when increased tonnage plus an improved product are vital.

Into the design and construction of 'Surface' Controlled Atmosphere Furnaces and Generators have gone the best engineering talent available. Each atmosphere type has been developed to 'shoulder' a definite set of responsibilities in the treatment of steels (or non-ferrous metals) and to do its job well. Nothing has been overlooked to make 'Surface' the "buy word" in dependable controlled atmosphere equipment and its applications.

'*Surface*', acknowledged as a great name in the Steel Industry for over a quarter-of-a-century—with hundreds of successful Steel Mill installations to its credit—invites you to share in its experience and 'know how' in the interest of quality . . . an improved product at worthwhile savings.

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

FOREIGN AFFILIATE COMPANIES

BRITISH FURNACES LIMITED—CHESTERFIELD
STEIN & ATKINSON, LTD.—LONDON
STEIN & ROUBAIX—PARIS, LIEGE AND GENOA
WILL L. SMITH, S.A.—BUENOS AIRES

Washed iron ore is stacked at rate of 600 long tons per hour by this 570 ft. track-mounted trailer belt conveyor (fed by fixed belt conveyor) and Link-Belt 115 ft. radius revolving, self-propelled stacker, which can make storage pile 42 ft. high.

Rely on one source... one responsibility for the best in belt conveyors

LINK-BELT engineering experience plus quality components combine to cut handling costs

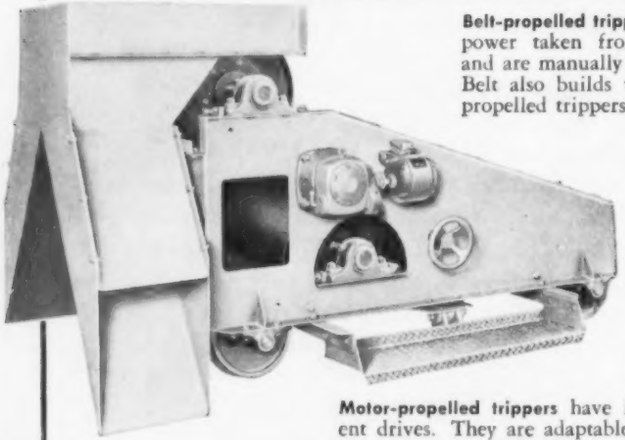
WHETHER you must move a few tons a day or several thousand tons per hour . . . whether the haul is measured in feet or miles—you'll find the answer in belt conveyors at Link-Belt.

Here's a nation-wide engineering organization that will follow through from start to finish—the designing, manufacturing, erecting of conveying equipment. And nowhere can you match Link-Belt's combination of vast application experience . . . complete line of quality components . . . expert coordination of related equipment.

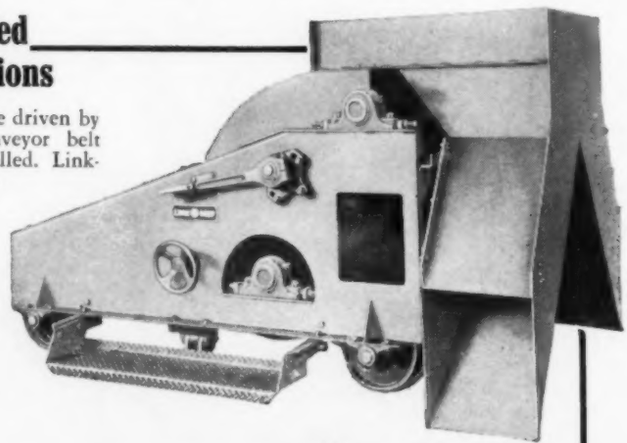
Get all the facts from the Link-Belt office near you. Link-Belt engineers are glad to work with you and your consultants—help you get the finest in belt conveyors.

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, Duluth, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities.

LINK-BELT Trippers offer controlled distribution under all conditions



Belt-propelled trippers are driven by power taken from conveyor belt and are manually controlled. Link-Belt also builds winch-propelled trippers.

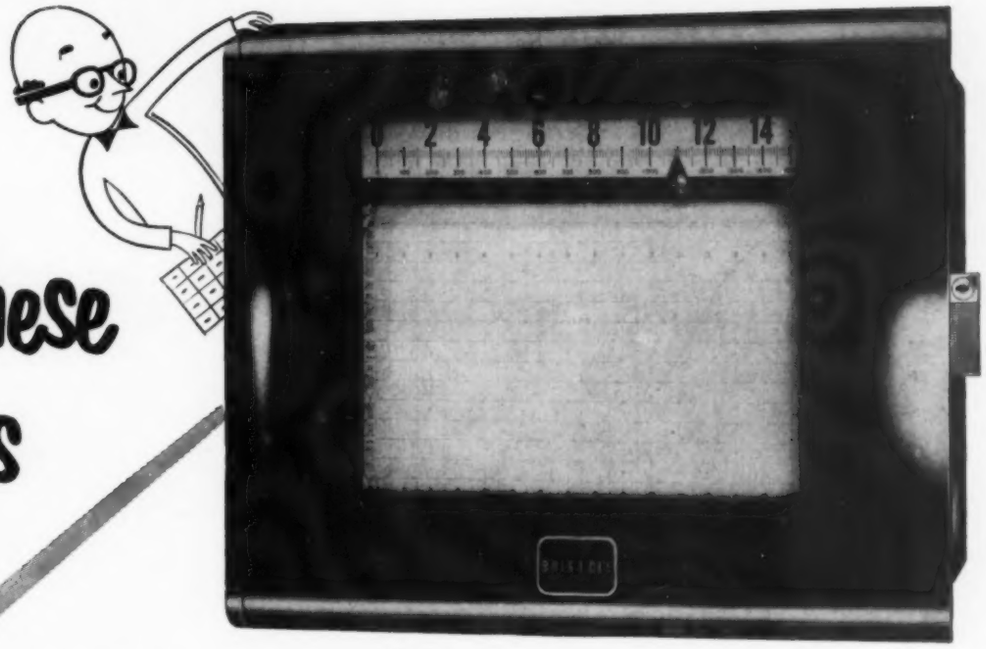


Motor-propelled trippers have independent drives. They are adaptable to automatic operation and control.

12,680-ft

LINK-BELT

BELT CONVEYOR EQUIPMENT



Check these features OF THE BRISTOL DYNAMASTER

—the electronic master-mind for your temperature measuring, recording and controlling problems

✓ Continuous-balancing electronic circuit responds instantly to minute changes

✓ All types of electric and air-operated controllers offered

✓ Available as a self-balancing bridge or potentiometer

✓ Trouble-free operation

✓ Electronic component uses vacuum tubes available at any radio supply house

✓ Full-scale pen travel in 7, 3 or ⅔ seconds

✓ Chart speeds from ¾ in. per hour to 7200 in. per hour

✓ Multiple recorders up to 16 points

✓ Components interchangeable and easily replaced on all Dynamaster models

✓ Immune to most vibration or shock

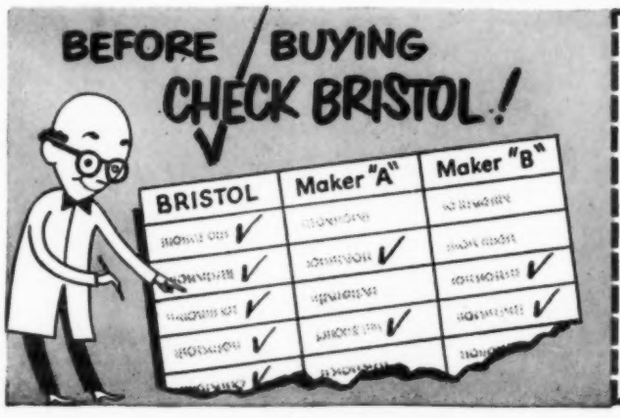
✓ Exceptionally unaffected by stray currents (1000 to 1 discrimination).

BRISTOL

FOR DETAILED PROOF *of the sensitivity, versatility and reliability of the electronic Dynamaster, use the coupon or write for Catalog P1245.*

The dependable Guidepost of Industry

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



THE BRISTOL COMPANY
123 Bristol Road
BRISTOL, CONNECTICUT

Please send catalog giving details of Dynamaster performance to:

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

For Allegheny Ludlum...

Koppers builds new electric furnace melting shop

THIS modern, three-furnace electric melting shop, recently completed by the Freyn Engineering Department of Koppers, at the Watervliet Plant of Allegheny Ludlum Steel Corporation, has a rated capacity to produce 75,000 tons of high-alloy, stainless and specialty steel ingots per year.

Design of this plant is characterized by the efficient handling and easy flow of materials. It incorporates numerous novel features.

The project centers in a three-aisle building, covering about 60,000 sq. ft., providing stock house, furnace and pouring areas. Supplementary construction includes an office and locker-room building, a new 115/13.8 kv. substation, an addition to an existing substation, an extensive railroad track system with storage and dump sidings, an oxygen plant and other facilities.

Situated at the edge of the plant property, the new shop is built into a sharply rising hillside. The stock yard, on a common elevation with the furnace platform, provides level movement of materials to the furnaces. The stock yard is equipped with 33 heavy timber bins for scrap. A series of 32 concrete alloy and material bins provides natural flow into the furnace aisle.

Two of the electric furnaces are of 25 tons capacity; the third has a capacity of 12 tons. These furnaces are high-powered. The smaller furnace is provided with interchangeable shells.

The pouring aisle, on a lower elevation, is served by two 50-ton cranes and is provided with a versatile pouring platform with step-stools to accommodate variations in ingot heights.

Several months of operation have proved the capacity of this new plant to attain its projected tonnage and to stay within predicted operating costs.

Constructing electric furnace melt shops is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers. You are invited to consult with our Engineers and Management.

KOPPERS

Engineering and Construction Division

KOPPERS COMPANY, INC. **PITTSBURGH 19, PA.**

The most widely used high temperature block insulation for over a quarter century...

SUPEREX® high temperature block insulation has long been industry's No. 1 choice for service temperatures up to 1900F. It provides *major* economies . . . reduces fuel costs, cuts heat losses, keeps maintenance expense down, costs less to install and has long service life.

These are the reasons why 90% of the nation's hot blast stoves are Superex insulated . . . and why the low cost open hearth steel producers use Superex in their regenerators.

Made of specially selected and calcined diatomaceous silica blended with other insulating materials and bonded with asbestos fiber, Superex will safely withstand temperatures up to 1900F with negligible shrinkage.

Superex has been used with outstanding success in all types of industrial and metallurgical furnaces and ovens, stationary and marine boilers, auxiliary power plant equipment, regenerators, kilns, roasters, high temperature mains, flues and stacks.

Superex has all these important advantages...

Low thermal conductivity—Exceptionally high heat resistance (1900F) combined with excellent insulating value.

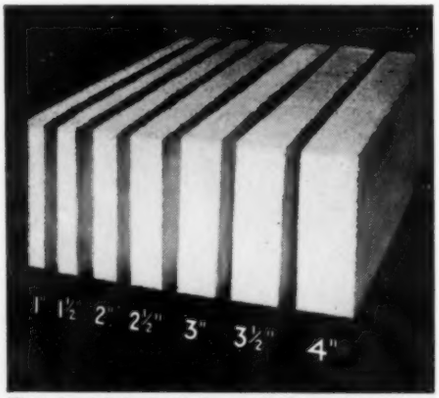
Light weight—Approximately 2 lb per sq ft per in thickness.

Great physical strength—Approximately 6 tons pressure per sq ft are required to compress Superex ½ in.

Long, efficient service life—Superex maintains high insulating value indefinitely—will not disintegrate in the service for which it is recommended.

Fast, easy application—Superex may be cut with an ordinary knife or saw for fitting around openings or to irregular surfaces. Because of its light weight and convenient sizes, Superex assures fast and economical installations.

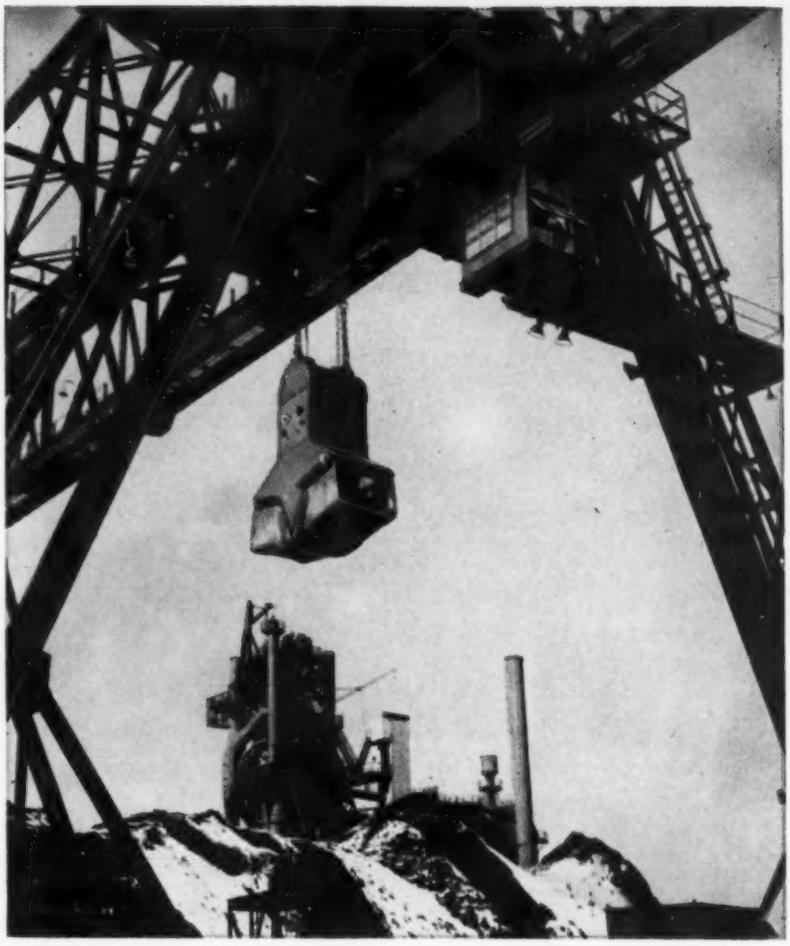
For complete information about Superex block insulation, write for Brochure IN-134A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, write 199 Bay Street, Toronto 1, Ontario.



Waste is minimized with Superex because of the variety of thicknesses available. Special shapes and intermediate thicknesses between those shown are also available.

JOHNS MANVILLE JM PRODUCTS

Johns-Manville *first in* **INSULATIONS**



During 1953...

When Your BETTER PRODUCTION PLANS *Call For* Heavy Bulk Materials Handling Equipment

Depend On

Heyl & Patterson

For

Advanced Design

and

Controlled Low Cost

The Heyl & Patterson "TURN-KEY WAY" is a plan of operation wherein each essential function, from design to guaranteed successful operation is performed completely within our own organization.

The "TURN-KEY WAY" enables Heyl & Patterson to guarantee successful operation and Controlled Low Cost.

It calls for Engineers, Fabricators and Erectors instilled with the urge for constant improvements . . . improvements based on actual past experience and on modern thinking and planning with one objective . . . *Designing, Fabricating* and *Erecting Better Heavy Bulk Materials Handling Equipment.*

Heyl & Patterson Engineers have undivided responsibility for the successful operation of all H&P projects. They call the signals and then the H&P Team goes into action.

We have *OUR OWN* Engineering Department . . . *OUR OWN* Research Department . . . *OUR OWN* Structural Shop . . . *OUR OWN* Machine Shop . . . *OUR OWN* Erection Department.

All departments work in complete harmony with a mutual understanding that the completed project has to be another tribute to the world-wide reputation of Heyl & Patterson.

- Ore Bridges
- Railroad Car Dumpers
- High Lift-Turnover-Rotary
- Coal Preparation Plants
- Coal & Coke Handling Equipment
- Boat Loaders and Unloaders
- Rotary Mine Car Dumpers
- Coal Crushers
- Coal Storage Bridges
- Car Hauls and Boat Movers
- Bradford Breakers
- Refuse Disposal Cars
- Thorsten Coal Sampling Systems
- Kinney Car Unloaders
- Pig Iron Casting Machines
- Cyclone Thickeners
- Thermal Dryers
- The Drying Dutchman
- Reineveld Centrifugal Dryer

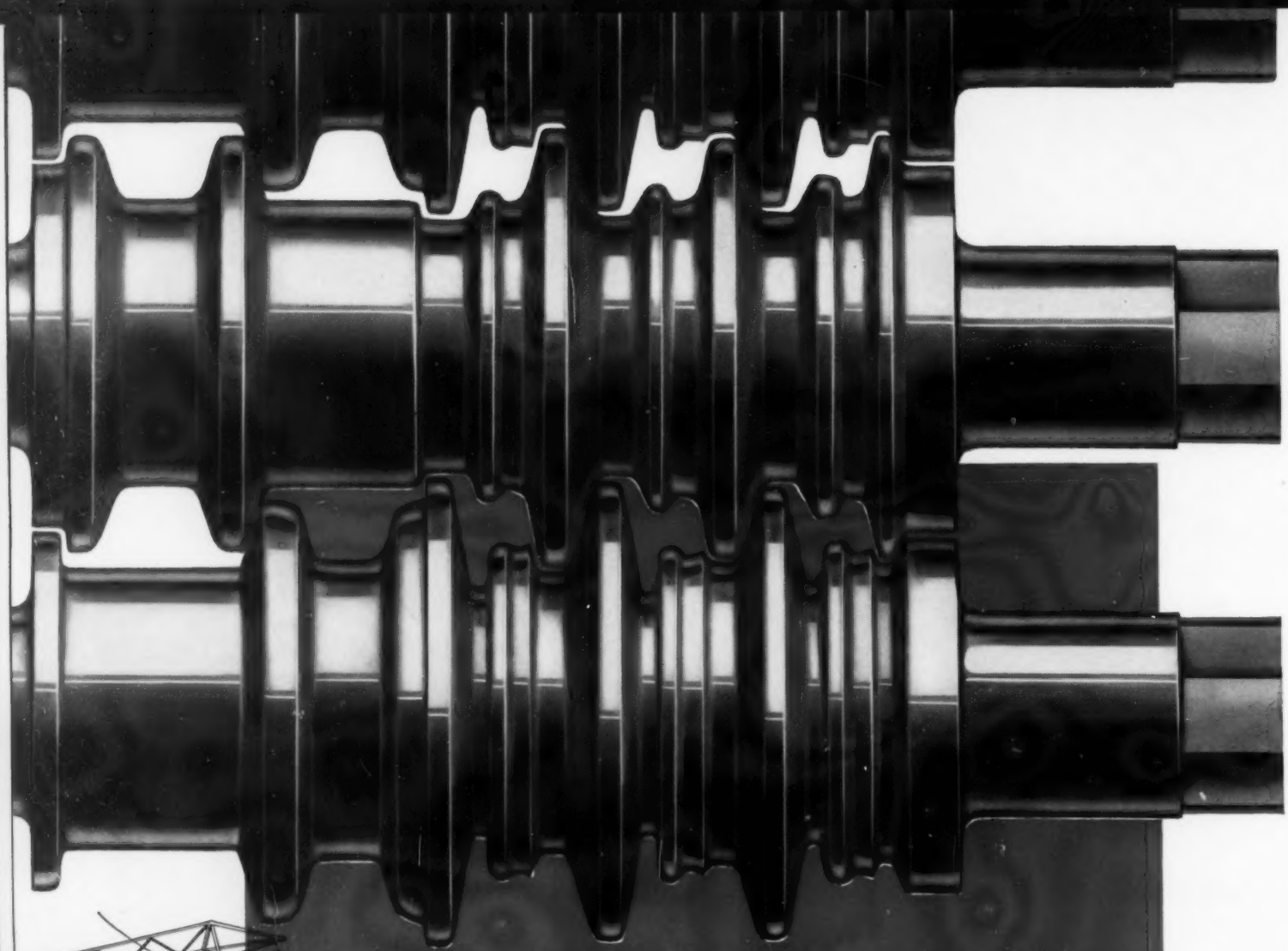
Heyl+Patterson, Inc.

"SINCE 1887"

Heavy Bulk Materials Handling Equipment

All The Way from Design to Erection

55 WATER STREET · PITTSBURGH 22, PA



Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

STEPPED-UP PRODUCTION

Greatly-enlarged plant facilities at Lima mean more Ohio Rolls to enhance your production. Choose from 11 types of Ohio Iron and Steel Rolls:

- Carbon Steel Rolls
- Ohioloy Rolls
- Ohioloy "K" Rolls
- Holl-O-Cast Rolls
- Chilled Iron Rolls
- Denso Iron Rolls
- Nickel Grain Rolls
- Special Iron Rolls
- Nioloy Rolls
- Flintuff Rolls
- Ohio Double-Pour Rolls

THE OHIO STEEL FOUNDRY CO.

LIMA, OHIO • PLANTS AT LIMA AND SPRINGFIELD, OHIO

Industry News...

EXPANSION OF COKE PLANT FACILITIES PLANNED BY WEIRTON STEEL DIVISION

▲ Plans for the construction of a new coke plant, an extension to the present coke department, were announced by President Thomas E. Millsop of the Weirton Steel Co., division of the National Steel Corp.

Plans for giving Weirton the ultimate in coke producing facilities were made public following announcement in Washington that the Defense Production Administration had approved for Federal tax assistance the proposed $24,750,000 expansion program.

The new plant will consist of two batteries of 41 ovens each and an extension to the coal handling facilities at the river docks. The latter will include barge unloading equipment and coal storage bins, increased capacity for the present coal conveyors and miscellaneous handling facilities.

A coal storage unit will also be built to take care of the increased capacity in coal requirements. Five new modern barges will be built to haul the new requirements of coal from the Weirton Steel Co. mines at Morgantown, W. Va. and Isabella, Pa.

Capacity will also be increased in the coke screening station and a conveyor erected for transferring the coke plant to the High Line for the new Number 4 blast furnace recently erected and placed in operation and the three original Weirton blast furnaces.

The plans, as given in detail by C. J. Klein, vice president in charge of engineering, include installation of a new bi-product and benzol department to handle the increased capacities in materials coming from the new ovens.

Equipment will be installed for the elimination of air pollution as well as the cleaning of the water being discharged to the river.

The increased coke oven gas production which will come from the additional ovens will be de-sulphurized in order to utilize same in the open hearth, as well as various other departments of the mills.

The extension to the present coke oven department will provide for an increase in production of the carbonization of 2000 tons of coal per 24 hr period. When the installation is entirely completed Weirton Steel's coke production will be increased to 5000 per day.

In addition to the various miscellaneous operating and servicing units described by Mr. Klein, other units will be installed to provide Weirton Steel with the ultimate in coke producing features.

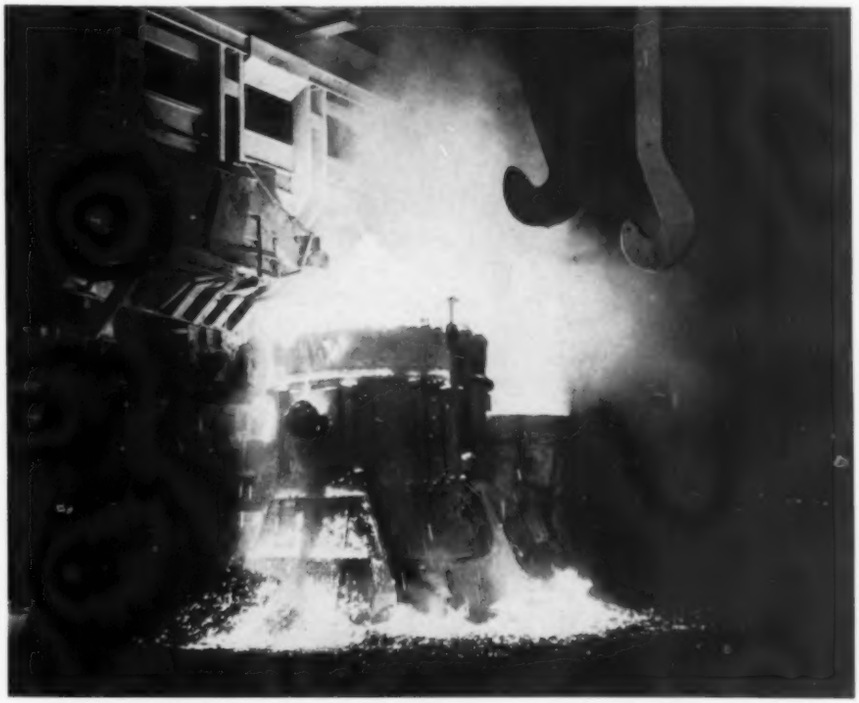
Field construction on the big project is to begin within five months, following the winter's end and the first unit of the new extension will be placed in operation in the early spring of 1954.

AMERICAN STEEL & WIRE REBUILDS "BATTERY B"

▲ With officials of American Steel & Wire division of U. S. Steel Co. looking on, the rebuilt "B Battery" of 45 coke ovens at the division's coke works were lighted November 15.

Among those present were Harry L. Jenter, assistant manager — operations, Cleveland district; John E. Allen, general superintendent, Central Furnaces and Coke works; Emmett A. Brady, works superintendent of the division's Cleveland coke works (located at 2145 Harvard Avenue); and F. R. Buskirk, former superintendent of the coke works and now special assignment engineer.

U. S. STEEL POURS ONE BILLIONTH TON



United States Steel poured its one billionth ton of steel on November 26. No other company in history, and no other nation on earth, has ever equalled this production record. This pouring was accompanied by a ceremony at the company's open hearth furnace No. 65 in Homestead district works. Top officials of the company including the newly elected president of U. S. Steel, C. F. Hood, attended to lend employes a hand in the historic steel-pouring event. It took 51 years, 7 months and 25 days of the U. S. Steel Corp.'s operations to produce 1,000,000,000 tons. At today's pace it would take only 30 years to produce the second billionth ton in the present mills of U. S. Steel, which represent only about one-third of the steel industry in this country. Seven veteran steelmen, who were working at Homestead in 1901 when U. S. Steel tapped its first ton of steel, were among those assisting at the tapping of the billionth ton.

Harry L. Jenter (center) assistant manager of operations, Cleveland district, looks on as the 45 rebuilt coke ovens in Battery "B" at the American Steel and Wire division's Cleveland coke works are relighted. F. R. Buskirk, (left) now special assignment engineer, uses a specially built flambeau or torch to light the ovens for the start of a 45-day warming-up process. Left to right are Buskirk, John E. Allen, general superintendent of Central Furnaces and Coke Works; Jenter; Emmett A. Brady, present superintendent of the plant; and George A. Curran, oven department superintendent.

This is one of four batteries of ovens at this plant. These 45 ovens, which produce about 500 tons of coke per day, have been in continuous operation for 15 years.

A flaming gas torch was placed in each of the ovens to ignite the gas burners. However, it will be more than a month before the ovens will go into actual operation. This is because a period from 38 to 45 days is required for the long and slow process of drying out the silica clay and fire clay used in rebuilding the oven. Temperatures will be kept very low for the first few days and as the drying out process is carried on, the temperature will reach 2200 F when the first charge will be made preparatory to producing coke. When a faster cycle is achieved, temperatures go as high as 2650 F.

The new installation involved a complete relining of a 200 ft stack serving this battery.

Now that the ovens have been lighted and the drying out process started, the next step which will begin next week will be the installation of a new collecting main. By means of this

ALWAYS READY TO SERVE STEEL PRODUCERS

IN spite of the best of operating practice, blast furnace copper castings and steel mill bronzes wear out and must be replaced and replaced QUICKLY!

Blast furnace and steel mill new construction projects require copper and bronze castings ON SCHEDULE.

Your experience has convinced you that *you can expect immediate* and *scheduled* deliveries of QUALITY copper and bronze castings from THE FALCON BRONZE COMPANY.

FALCON

COPPER
Valve Seats
Valve Gates
Inwall Plates
Bosh Plates
Tuyeres
Coolers
Monkeys
COPPER AND BRONZE CASTINGS

Telephone Collect 3-4186
FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 · Incorporated 1895

LICENSED MAKERS OF ALL PATENTED DESIGNS
DEPENDABLE FOR 62 YEARS · SINCE 1890

HAVE *Strength* WHEREVER STRENGTH IS NEEDED

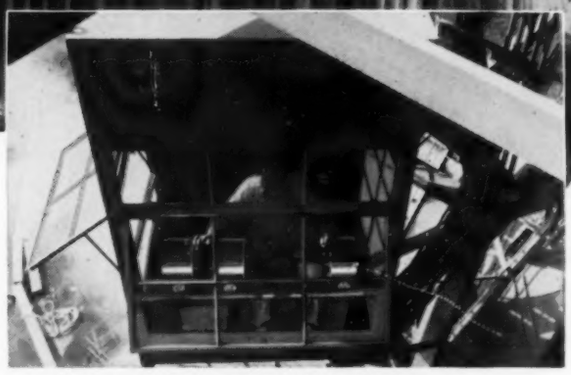
Satisfying A.I.S.E. specifications, Browning Mill Type Cranes incorporate types of motors and controls on which you have standardized. This flexibility suits your VRB crane *perfectly* to your needs. Our design, springing from 49 years' experience, places plenty of strength where it is required.

Ask for our Bulletin "E"

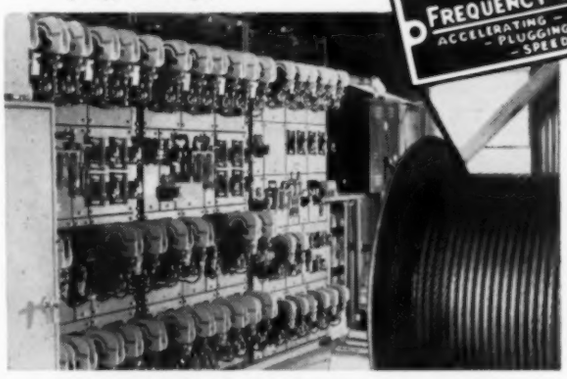
Husky 10-ton mill type trolley equipped with separate load girt for easy removal.

VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

Fast Lifts–Safe Lifts WITH EC&M CONTROL easy to operate, TOO



Narrow-width EC&M Cam Master Switches are closely grouped for operator's convenience on this 720 ton-per-hour Barge Unloader, designed, fabricated and erected by Heyl & Patterson for the Duquesne Slag Company, Pittsburgh, Pa.



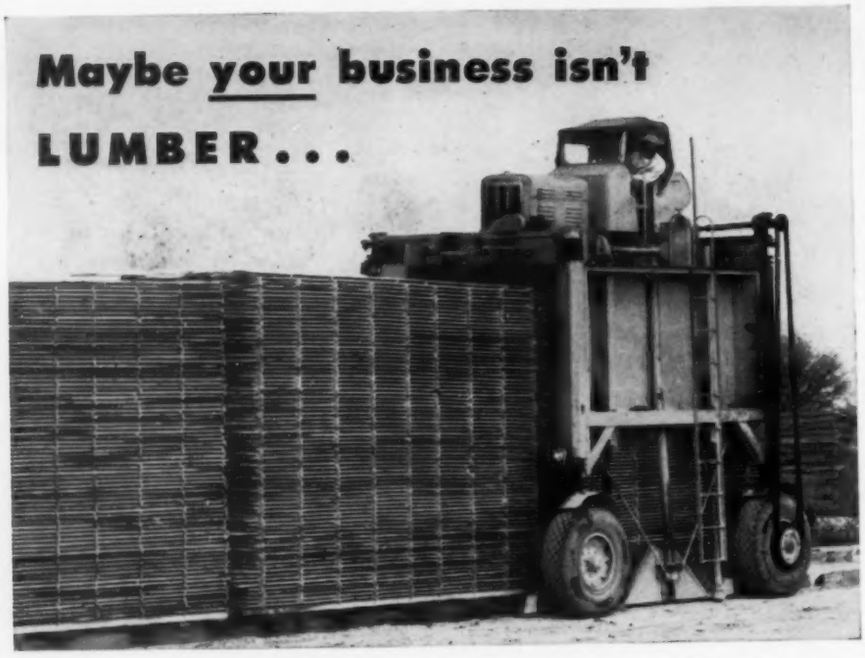
EC&M LINE-ARC Contactor Controllers for Closing & Holding Line Motors and for the Trolley Motion are EC&M Frequency Relay Controlled for fast, safe operation.

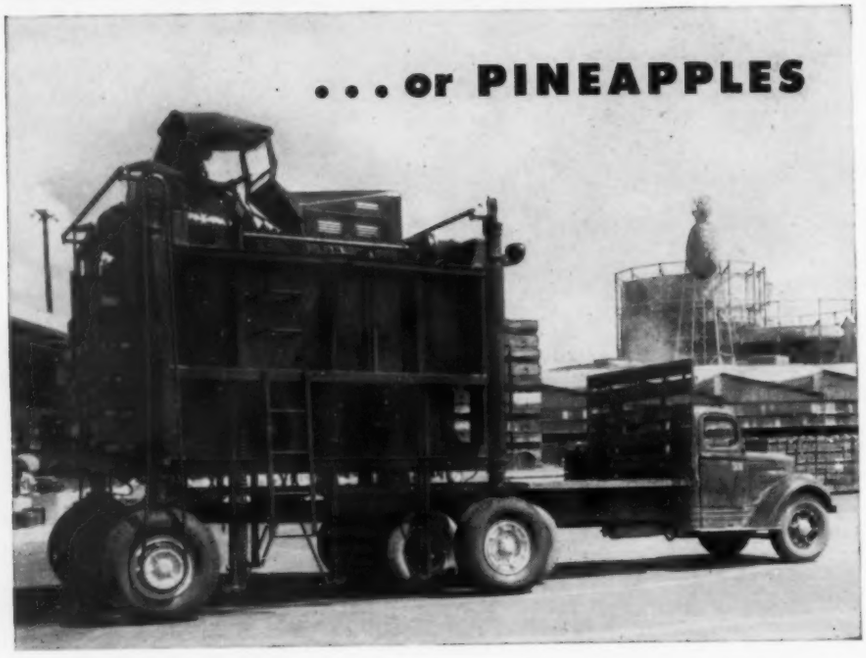
Output increases and costs go down when operators find rhythmic response at their finger-tips. Paying out cable to dig into the pile, taking the swing out of a loaded bucket at the point of discharge, and keeping the bucket open when lowering for another load are time-savers on bulk material-handling applications.

On river unloading stations, at lake and ocean ports, EC&M Control has a reputation among operating management for fast handling because bucket manipulation, trolley travel and similar operations respond quickly to the operator's needs. Straight-line, lever-operated EC&M Cam Master Switches have a short throw in both directions—are less tiring on the operator—the off-point is distinct and easy to find when returning from any of the speed-points. Put your control applications up to EC&M.

It pays to specify **EC&M Control—control engineered for high output with safety.**

THE ELECTRIC CONTROLLER & MFG. CO.
2698 EAST 79TH STREET • CLEVELAND 4, OHIO





BUT . . . just imagine the savings you could make, the problems you could solve by handling your materials with ROSS Straddle Carriers, the most flexible and most adaptable mass material handling method known!

ROSS engineers will be glad to work with your materials handling men in exploring the possibilities of ROSS Straddle Carriers for your operations . . . there's no obligation.

Send for details on ROSS Straddle Carriers . . . 10,000 lb., 20,000 lb., 35,000 and 45,000 lb. capacities.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Distributors throughout the world.

400 Miller St., Benton Harbor, Michigan, USA

device, smoke which develops when coke ovens are charged will be drawn into the main by special aspirators. This feature, plus the fact that the ovens have been rebuilt from the ground up, will contribute substantially to reducing air pollution, Mr. Jenter pointed out.

The rebuilding program has been going on for more than four months.

TCI ESTABLISHES NEW MONTHLY RECORDS

▲ In October U. S. Steel's Tennessee Coal and Iron division produced more iron and steel than it had ever produced in any previous month. Altogether, more than half a dozen new individual and total records were established.

At Ensley, Ala., works, three of the six blast furnaces topped all previous monthly production figures. At Fairfield, Ala., all three blast furnaces exceeded all previous performances, two of them for the second consecutive month. This was also the second month in a row that the Fairfield steel works blast furnace department boosted its total iron production to a record high.

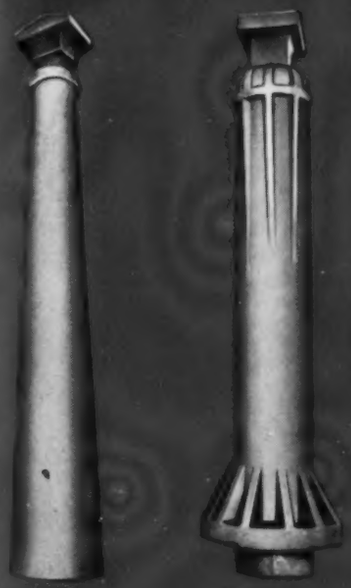
TCI's open hearth furnaces turned out more tons of ingots than they had ever done before. Added together, the figures showed that TCI during the month produced 7727 tons more iron and 6985 tons more steel than it had manufactured in any one month of its existence.

A breakdown of production figures shows that at Ensley, No. 2 blast furnace made 36,763 tons of iron during October, topping by 1500 tons its best previous record set in December, 1949; No. 4 furnace made 35,014 tons of iron, 1365 tons more than it had made before in a single month; and No. 6 improved its best previous record for ferromanganese production by 292 tons, casting a total of 7080 tons. That furnace also set a new record in September.

At Fairfield, No. 5 blast furnace produced 31,632 tons, which was 1020 tons more than it made in March, 1952, its second best period; No. 6 furnace set a record of 32,578 tons, an improvement of 1856 tons over its record-breaking tonnage of the month before; and No. 7 furnace bettered its all-time high of September by 2647 tons, raising its production to 43,324 tons.

The Fairfield blast furnace department as a whole produced 107,534

..ALL MUSCLE!



Unusual stresses, strains, shock, abrasion, fatigue, are all thoroughly studied before Union makes a mold or pours a heat. The careful consideration of these important factors plus the high-strength steel that goes into Union Steel Castings insure the very best in performance.

They're "all muscle"!

"UNION" MAKES

GEARS & PINIONS • TONGS & TONG LEVERS • UNIVERSAL COUPLINGS & SPINDLES
CHARGING BOXES • PEELS • SLAG POTS • INGOT CARS & CHARGING BOX CARS
SPECIAL UNIVAN & ARMOR • STEEL CASTINGS

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

OFTEN THERE IS NO SUBSTITUTE FOR A *GOOD LOOK*

That's Why Industry Needs the

DIAMOND "UTILISCOPE"

(WIRED TELEVISION)

A description may help find a suspect, but before identification can be positive enough to stand in court, somebody who knows the man must take a good look at him.

In many industrial processes, there also is no substitute for a good look. Correct control depends upon the operator having a SENSE OF REALISM that instruments cannot provide . . . that SEEING alone can give.

The Diamond "Utiliscope" (wired television) enables the operator to have a "good look" at all times no matter how remote, inaccessible or dangerous the location of the process. The "Utiliscope" is exceptionally rugged, reliable, and moderate in cost. There undoubtedly are places in your plant where it will save money, improve quality, promote safety and/or reduce manpower requirements. Write for Bulletin.

TYPICAL USES—Studying destructive tests of engines • Watching flow of molten steel • Checking remote gauge readings • Observing conditions inside furnaces • Viewing nuclear research • Coordinating materials flow on conveyors • The "Utiliscope" (Registered U. S. Patent Office)

WRITE FOR BULLETIN 1025E

DIAMOND POWER SPECIALTY CORP.

FIRST IN INDUSTRIAL TELEVISION

LANCASTER, OHIO • *OFFICES IN 39 PRINCIPAL CITIES*

Diamond Specialty Limited—Windsor, Ontario

Since 1903, Diamond has Manufactured Quality Equipment For Industry

6064

tons, as compared with its record-shattering 101,244 tons last month.

The Fairfield open hearth furnaces also raised their steel ingot production above all previous peaks, producing 134,761 net tons. A new monthly record for the division as a whole was established, with a total monthly production of 289,987 tons.

United States Steel Corp. as a whole broke all production records in October by turning out a total of 3,195,761 net tons of steel, an increase of nearly 120,000 tons over the previous high mark of 3,076,575 net tons in March, 1952.

Scores of U. S. Steel plants and many individual shops in all sections of the country contributed to this production record. A world record was chalked up by the open hearth shop of the National Tube plant in McKeesport, Pa., where an average output of 51.6 net tons of steel was produced per operating furnace hour during October.

Record production was achieved also by many of U. S. Steel's blast furnaces, rolling mills, and shipping departments in all of its steel-producing centers.

The record-breaking output by United States Steel exceeded by some 300,000 tons the entire estimated monthly output in Russian steel plants.

AIRCO COMPLETES UNION DIVISION PLANT

▲ The opening of the Union, N. J. plant of the Airco Equipment Manufacturing division of Air Reduction Co., Inc., was announced recently.

The new facility has begun manufacture of welding and cutting torches, tips, regulators, oxygen and acetylene manufacturing and distribution equipment, gas-arc welding apparatus and oxyacetylene cutting machines. The new plant houses the entire Airco Equipment Manufacturing division.

The more than 12,000 different items produced by this division are sold domestically by various other Air Reduction divisions; in Canada by Air Reduction of Canada, Ltd., in Cuba by Cuban Air Products Corp. and internationally through Airco Co. International.

Physically, the plant is of brick and steel construction, covering approximately 272,000 sq ft, on a 25-acre plot. The 18,000 sq ft of office space

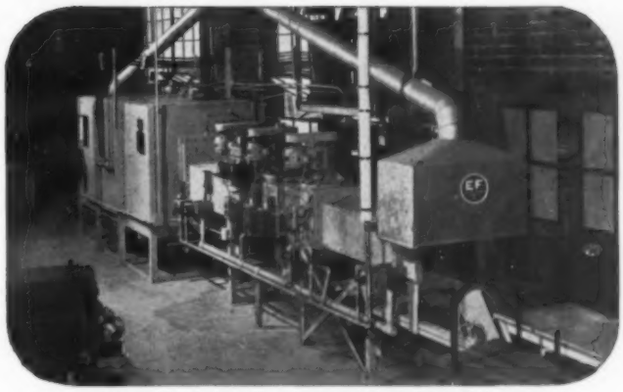
Straight lengths of brass and copper tubing are also bright and scale-free annealed in this EF gas fired furnace. Capacity 4000 lbs. per hour.

EF gas fired forced convection continuous roller hearth special atmosphere furnace bright annealing long straight lengths of tubing.

ANNEALING TUBING BRIGHT *and* CLEAN *Continuously*

• We have built many outstanding production furnaces for processing copper, brass, stainless, aluminum, nickel silver and other ferrous and non-ferrous tubing . . . in large and small coils . . . straight lengths, long and short, and in various diameters . . . also for wire, strip and many other products and processes.

Put your production furnace problems up to experienced engineers . . . *it pays.*



A special atmosphere belt conveyor electric furnace annealing short lengths of alloy tubing—operates at temperatures up to 2040° F.

3000 lbs. of steel tubing, per hour, are bright normalized in this EF gas fired radiant tube type special atmosphere furnace.

Straight lengths of tubing up to 5" in diameter and ¾" thick are also annealed in this EF forced circulation roller hearth furnace.

Gas-Fired, Oil-Fired EF and Electric Furnaces

for any Process, Product or Production

THE ELECTRIC FURNACE CO.

WILSON ST. at PENNA. R. R. *Salem - Ohio*

Canadian Associates • CANEFCO LIMITED • Toronto 1, Canada

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

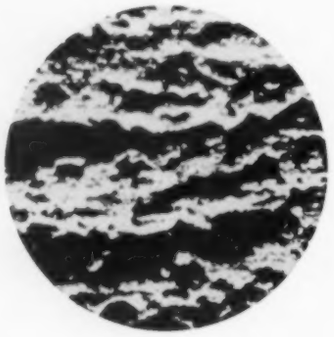
Technical Service Data Sheet

Subject: EFFICIENT PICKLING WITH RODINE®

ADVANTAGES OF "RODINE"

RODINE is used in sulfuric and muriatic acid baths for improved pickling and increased production. It meets Government Specification U.S.N. 51-I-2.

In straight line pickling of wire, rod and tubing, RODINE makes available more metal for drawing by protecting steel from acid attack. In batch pickling of sheet steel, RODINE improves the surface. In rapid, continuous strip pickling, RODINE not only saves acid and metal, but also prevents over-pickling during line shutdowns.



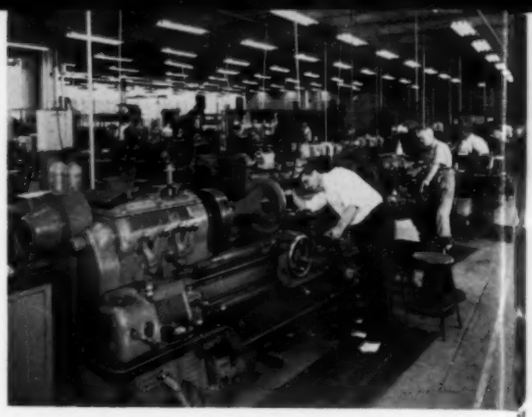
This steel surface was pickled in an uninhibited acid bath. Note the deep pits, and that the surface is visibly crystalline.

This surface was pickled exactly like the one above except that "RODINE" was added to the acid solution. Only scale pockets and roll marks are visible; no pitting occurred.

CHEMICALS ACP PROCESSES

WRITE FOR DESCRIPTIVE FOLDER ON "RODINE" AND INFORMATION ON YOUR OWN PICKLING PROBLEM.

CHEMICALS ACP PROCESSES



Many of the intricate parts of Airco equipment pass through this portion of the machine shop as they move through the production process. Here, a battery of twelve metal-working lathes is turning out precision machined parts for Airco equipment.

is completely air conditioned. The entire plant has fluorescent lighting.

The property is adjacent to the main line of the Lehigh Valley Railroad and within a mile of U. S. Route 22 and N. J. State Highway 29.

LARGEST CUT NAIL PLANT OPENED AT LA BELLE

▲ More than 3000 visitors toured Wheeling Steel's La Belle works—the world's largest cut nail plant—during the recent open house in celebration of the plant's 100th anniversary.

Employees' families, Wheeling civic officials, and school groups were conducted through La Belle in small groups under guidance of Wheeling Steel sales personnel to see how open hearth steel sheet is sheared in strips, fed mechanically or by hand into cut nail-making machines, hardened, and packed in kegs for shipment to all parts of the world.

Wheeling Steel executives pause to watch one of the operations while making a tour of the La Belle cut nail plant during the centennial celebration in Wheeling, October 9, 1952. At the left J. H. McElhinney, vice president in charge of operations chats with a visitor while W. W. Holloway, chairman of the board, J. L. Neudoerfer, president and W. M. Hall, general manager of La Belle works watch nail making machinery.

A bronze plaque reading "La Belle Works — One Hundred Years of Cut Nail Making — Wheeling Steel Corp. — 1952" was dedicated by Forrest H. Kirkpatrick, assistant to the president. The plaque will eventually be mounted permanently on one of the large sandstone wheels used for sharpening the knives of nail machines, which will be set up on La Belle works grounds.

Although very little change has been made in the physical characteristics of cut nails since they were first produced in the Ohio Valley more than 100 years ago, they are still the only kind of nail experienced carpenters will use for laying hardwood floors or for joining wood to masonry. Annual production of Wheeling's La Belle works is approximately 240,000 kegs — in sizes ranging from 8-inch boat spikes to 7/8-in. clout nails.

Many of the men working at La Belle today are descendants of the fabulous "Ohio Valley Nailers" of the late eighteen hundreds whose earnings, fancy dress, and lavish homes became a national legend. Several La Belle employees have service records of more than 40 years.

NORTHWEST BAR MILL BUILT BY SIERRA STEEL

▲ To facilitate production and delivery to all industry and jobber distributors of cold finished steel, Sierra Drawn Steel Corp. of Los Angeles, Calif., has established a mill in Seattle, Wash., capable of handling cold finished bars from 1½ in. to 6 in. Sierra is the only independently-owned cold finishing bar mill in the west.

The new Seattle plant occupies 6.6 acres, is provided with a Union Pacific spur track for fast loading and shipment and is located in the southern industrial section near Boeing Airport. The subsidiary will be known as Sierra Drawn Steel of the North-West.

NEWARK SALES OFFICE MOVED BY RELIANCE

▲ Removal of the Newark, N. J., sales office of Reliance Electric & Engineering Co., Cleveland, Ohio, from its present location at 1060 Broad Street into newer and larger quarters at 535 High Street in Newark has been announced.

(*Please turn to page 183*)

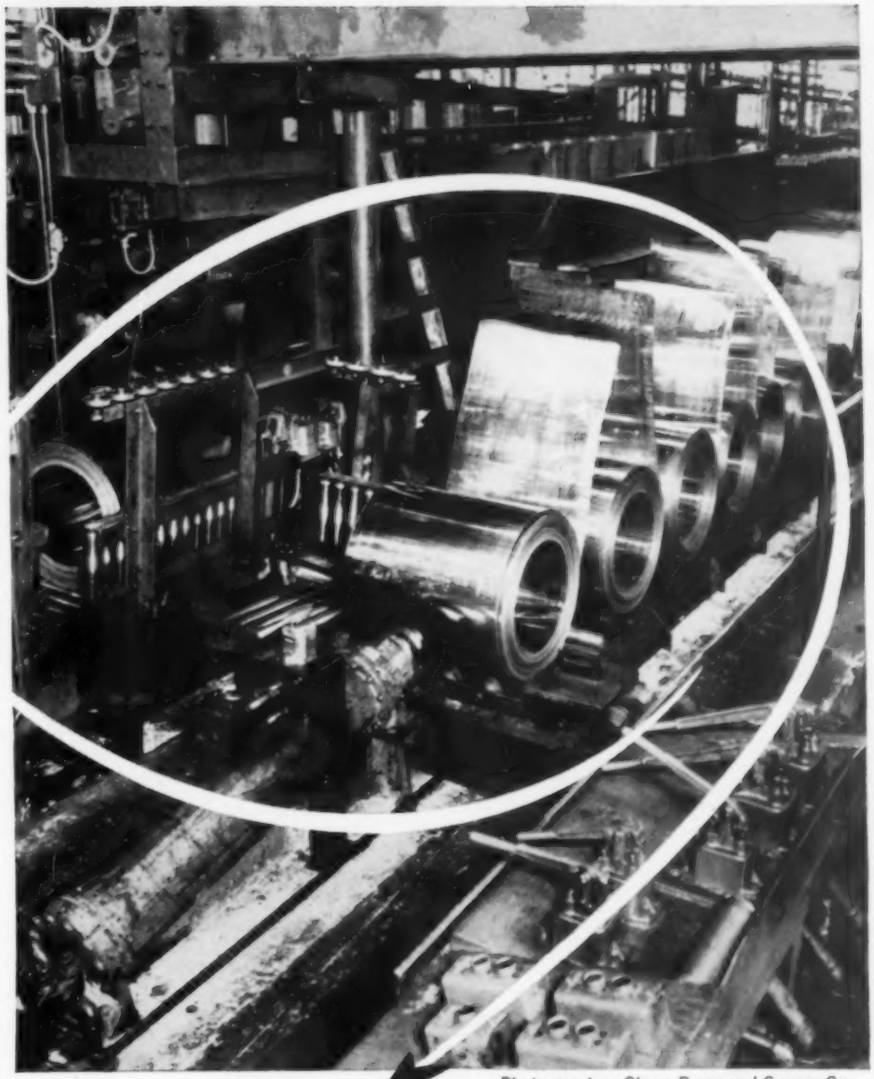


Photo courtesy Chase Brass and Copper Co.

WHAT IS "*Continuous Flow*" CONVEYING?

WE HEAR A LOT these days about **Continuous Flow** in materials handling. Years ago, when the first large, spectacular conveying systems were being developed, the words **Continuous Flow** were used to describe the extensive Mathews' systems of that type. They did not correctly apply then, nor do they now, to installations involving a few sections of roller or wheel conveyer, or a simple belt conveyer applied here and there. The term best applies to the jobs involving complete systems of conveying machinery which result in a smooth, mechanized flow of materials through receiving, processing, storage and shipping.

These broad engineering facilities and the necessary wide range of conveying equipment, have been the Mathews stock-in-trade for nearly 50 years. *Write for Catalog 852 today for examples of* ***Continuous Flow*** *conveying.*

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
ELLWOOD CITY, PENNSYLVANIA

PACIFIC COAST DIVISION . . *Mathews Conveyer Company West Coast*
SAN CARLOS, CALIFORNIA

CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

Engineering Offices or Sales Agencies in Principal American and Canadian Cities

They did what you can do to produce more

Weirton's new tinning line **is a three-high structure (background). The strip moves up through three decks where it's plated and washed. Reflow takes place as it descends the tower in back of Weirton department superintendent, Harry Reading, and tinplate manager, Al Kadell. Man in foreground runs the whole operation from his master control panel.**

The world's fastest tinning lines

This new tinning line of Weirton's is one of the world's fastest. It operates at 2,500 fpm, three times faster than most lines. Yet product quality is excellent. Westinghouse developed a drive with numerous advanced engineering features. See if they give you an idea for your new mills and process lines.

Two things make the high speeds possible: First, Westinghouse RF *radio frequency* heating is used to "reflow" the tin (and produce the shiny surface). Second, a special control system keeps the plating current proportional to line speed and assures uniform thickness. The highly synchronized drive ties the whole complex line together.

The RF heating works so fast it produces an actual "flow line" on the moving strip. An electric eye continuously scans this flow line and uses it to maintain the precisely desired heating rate. Thus despite variations in strip speed, thickness and moisture content, there's no danger of overheating or underflow.

Removing finished coils and adding new ones doesn't stop the line. Extra strip in looping pits provides for slow-speed operation during changes. And the controls prevent any quality variation during the slowdown. The final quality check is a pinhole detector in the trimming line which automatically rejects any imperfect sheets.

Call Westinghouse early on your next project. Integrating these developments into a high-production, high-quality line is one of the trickiest possible drive-engineering problems. And this kind of thinking can be applied to *all* steel mill projects. Call in Westinghouse early on your next job.

J-94910

YOU CAN BE SURE...IF IT'S Westinghouse

EQUIPMENT FOR STEEL PRODUCTION

ROTARY SHEAR?

no, this is a Rotary Shear

THIS Morgan shear can cut bars up to 3 sq. in. cross section area at speeds up to 3000 F. P. M. The opening and closing of the knives is performed hydraulically, dispensing with the use of magnetic clutches and brakes, thereby eliminating all "creep" and slippage. The action is positive and precise. The "V" shape cutting edge of the knives leaves no "beard" or slivers where the cut is made. Here we show twin shears for double strand rolling.

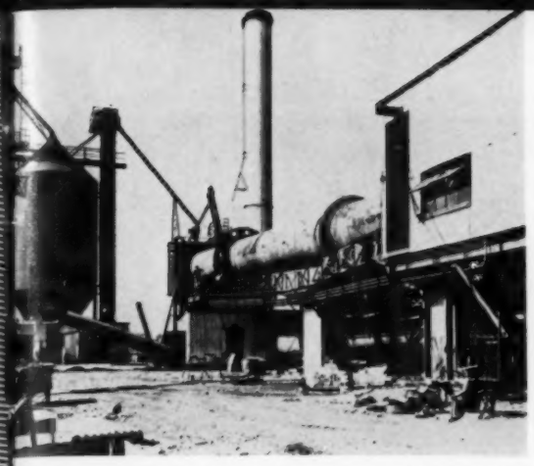
Do you have a rolling mill problem? We would like to work it out with you.

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Rep., International Construction Co., 36 Kingsway, London W. C. 2, England

ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES
REGENERATIVE FURNACE CONTROLS • EJECTORS • GAS PRODUCERS

RM-80



▲ In order to improve the quality and increase the supply of calcined coke for the production of graphitized carbon electrodes and other carbon products, the International Graphite & Electrode division of Speer Carbon Co. has installed a rotary calciner at their Niagara Falls, N. Y., plant.

The coke calcined in the new equipment will be used in the manufacture of electrodes and anodes for the metallurgical and chemical industries as well as to supplement the supply of raw material used in the main plant of Speer Carbon Co. for motor brushes, electrodes, and other carbon specialties.

NEW SAND "FOUNDATION" PLANT NEAR COMPLETION

▲ The first large plant in the United States to be constructed on sand compacted by "Vibroflotation" will be completed early in 1953 at Bonnie, Fla., for the International Minerals and Chemical Corp. of Chicago by Rust Engineering Co., the two companies announce.

A savings of ¼ million dollars was achieved by the method which enabled the Bonnie Phosphate Chemicals plant to be constructed on dry wasteland sands with no support other than the sand itself. The entire plant will cost $12,000,000.

Key to the new practice of building on sand is a sand compaction process called "Vibroflotation" which Rust Engineering Co. has been franchised to handle by its inventor, Sergey Steuerman, New York City.

Success of this new "foundation" concept may well mark a milestone on the path to greater use of hitherto economically unattractive sand areas such as river basins, shorelines, and deserts for industrial plant building, the companies concerned believe.

International Minerals chose the barren plant site near Mulberry, and about eight miles from Bartow, Fla., because of its proximity to the Bone Valley gravel from which it recovers phosphate.

The companies faced a foundation problem at this site since its soil must support not only heavy structures but take shock and vibratory conditions without settlement (which would be highly damaging to the process buildings with their maze of piping and chemical apparatus).

Soil studies showed the site was underlain with an uncertain base of loose sand, a "sandy matrix stratum," and a third layer of compressible sand and gravelly clay, to a depth of some 60 ft before reaching a suitable bearing strata.

The new process increases the relative density of sandy soil through a shaking and pushing process that packs the sand grains more closely and tightly together and reduces the voids or empty spaces between the

(*Please turn to page 189*)

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

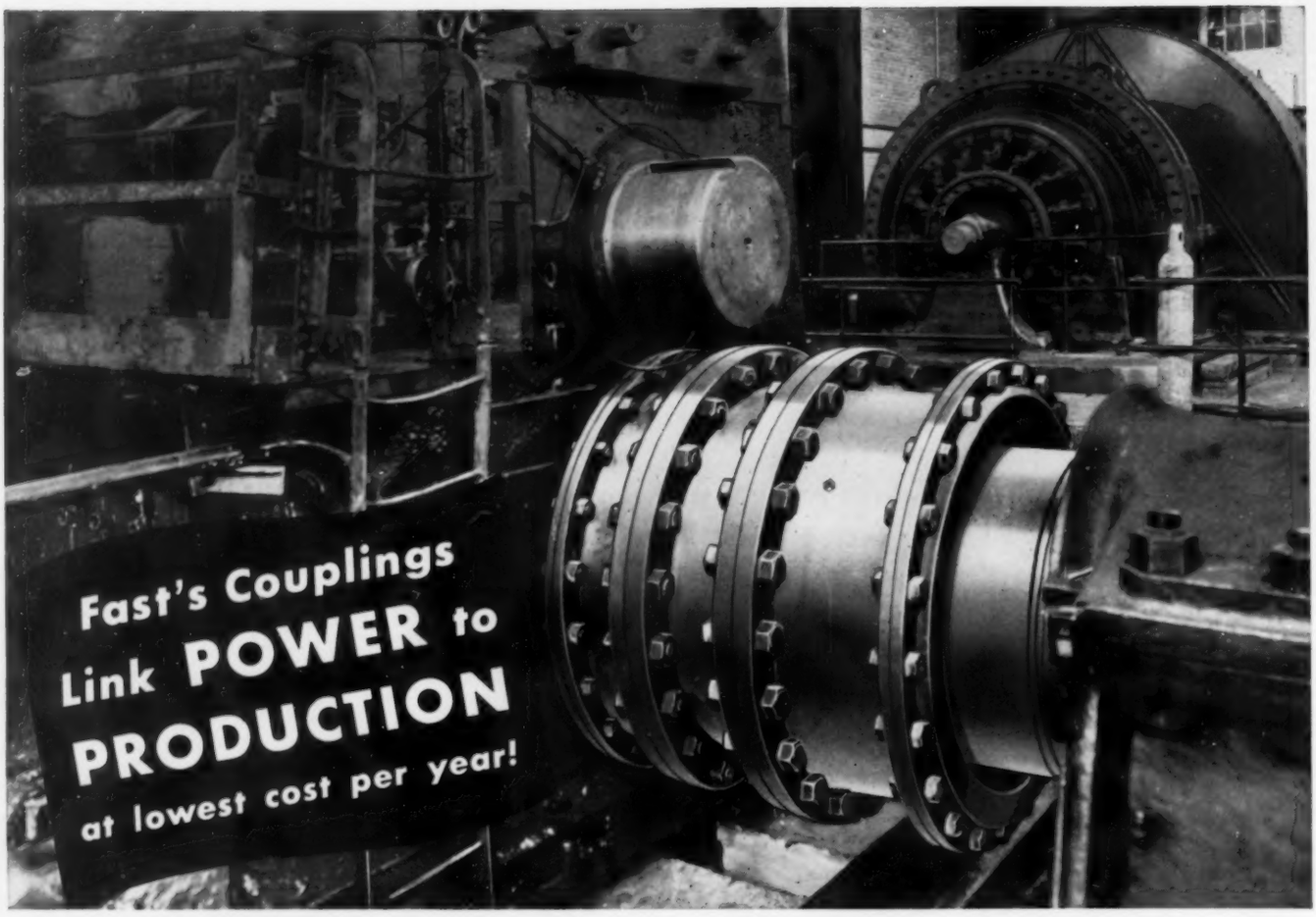
Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

245 MAIN ST., HARMONY, PA.



FAST'S Couplings usually outlast the equipment they connect!

ACTUAL cases on record show many Fast's Couplings are still in service after as much as 30 years of continuous operation! Time and time again, equipment has been replaced while the original Fast's Couplings remained on the job.

To you, these records of dependable, trouble-free service mean freedom from costly coupling failures when you specify Fast's. And they mean Fast's cost you far less to own and operate . . . because their cost can be amortized over long years of dependable performance.

For full details on how Fast's Couplings and Koppers Engineering Service can help you, write today for a free copy of our catalog to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 312 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS®

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*,
312 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

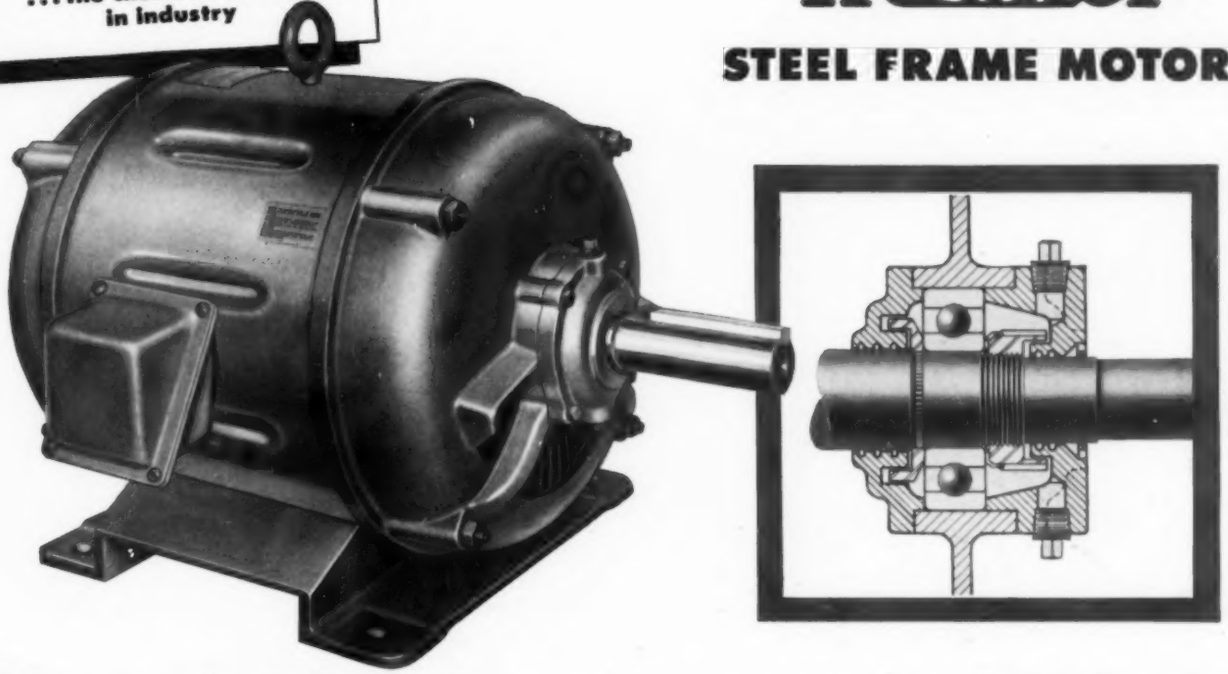
Company .....

Address .....

City ..... *Zone* ..... *State* .....

Wagner
ELECTRIC MOTORS
... the choice of leaders in industry

Wagner
STEEL FRAME MOTORS



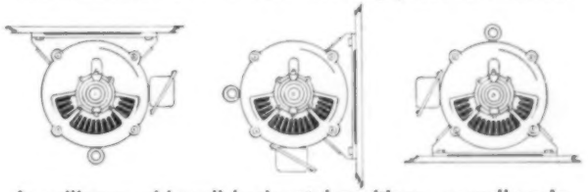
This sealed-bearing motor can be lubricated

Wagner Steel-Frame general purpose polyphase motors are equipped with labyrinth sealed bearing housings that effectively prevent the entrance of any dirt or grit that might cause premature wear. It is not necessary to lubricate the bearings—motors in the smaller frame sizes operate for years without relubrication. But... these Wagner Motors are provided with two lubrication openings — you *can* lubricate your motors when necessary or desirable, to add years of useful motor life in unusually severe applications.

Wagner's Bulletin MU-131 gives valuable information concerning proper lubrication of electric motors — Copies will be sent you on request.

DRIP-PROOF... 3 WAYS

These open-type motors (in frames 326 and smaller) are completely drip-proof in any horizontal position because there are no openings in the frame and the end-plates can be rotated 90° or 180° for drip-proof installation



in ceiling or sidewall horizontal positions, as well as in the normal horizontal position.

Wagner Steel-Frame Motors are available in electrical types to meet most industrial requirements. Bulletin MU-185 gives full information—write for your copy.

WAGNER ELECTRIC CORPORATION
6483 Plymouth Ave., St. Louis 14, Mo., U.S.A.

®Wagner Electric Corporation
EST. WE 1891

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

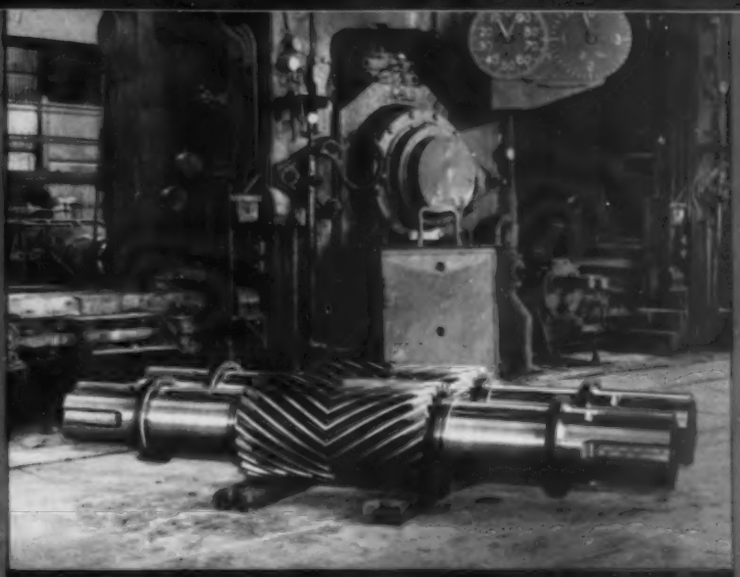
M52-17

TSP...MILL PINIONS TIMES

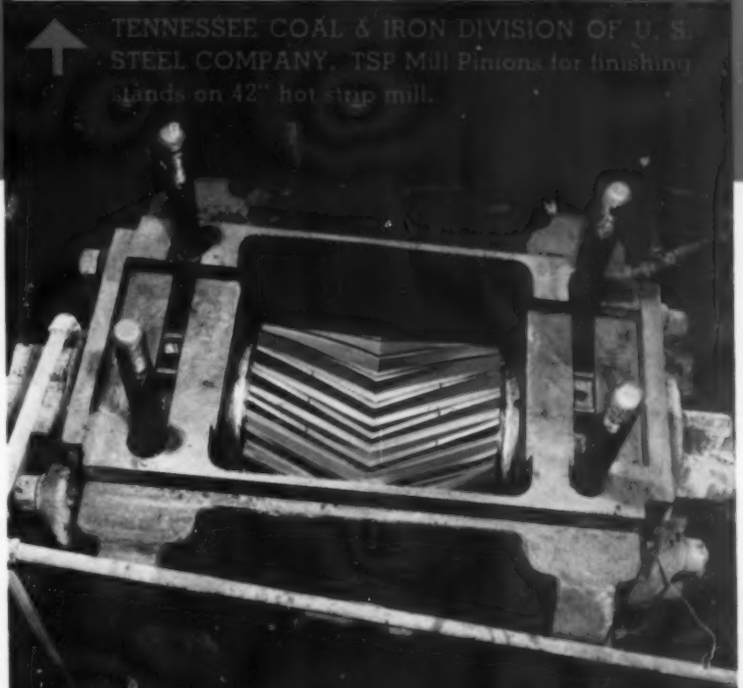
THE TOOL STEEL GEAR & PINION CO.
CINCINNATI 16, OHIO, U.S.A.

TOOL STEEL PROCESS PRODUCTS—THE STANDARD OF QUALITY SINCE 1909

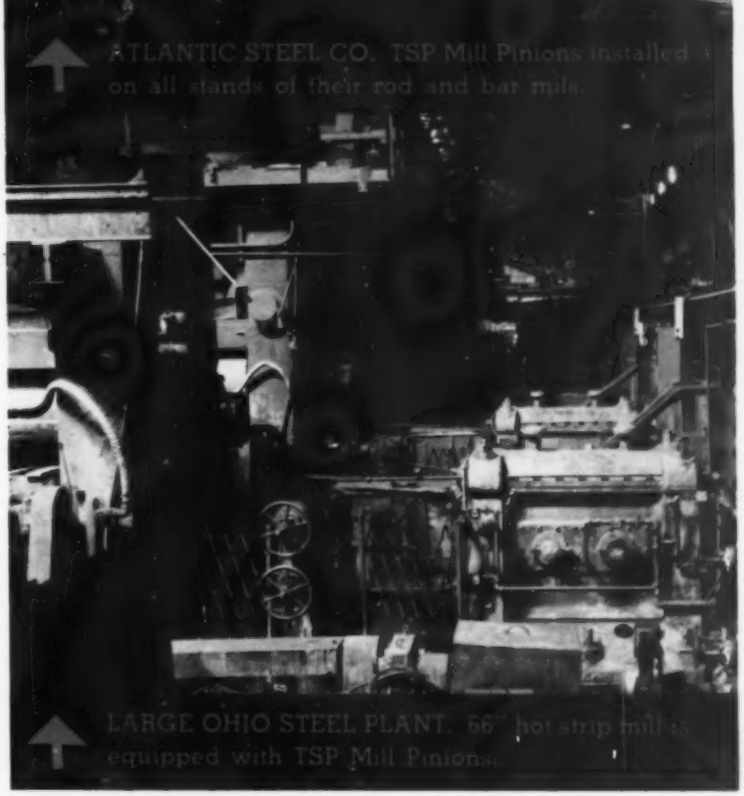
LAST 5 to 8 LONGER!



TENNESSEE COAL & IRON DIVISION OF U. S. STEEL COMPANY. TSP Mill Pinions for finishing stands on 42" hot strip mill.



ATLANTIC STEEL CO. TSP Mill Pinions installed on all stands of their rod and bar mills.



LARGE OHIO STEEL PLANT. 56" hot strip mill is equipped with TSP Mill Pinions.

Actual service life records available on "Tool Steel Process" Mill Pinions in both large and small mills show them giving up to 5 to 8 times the life of pinions formerly used.

HERE'S WHY: **TSP wearing surfaces are file hard for super resistance to wear and fatigue. Cores are tough and ductile for maximum strength.**

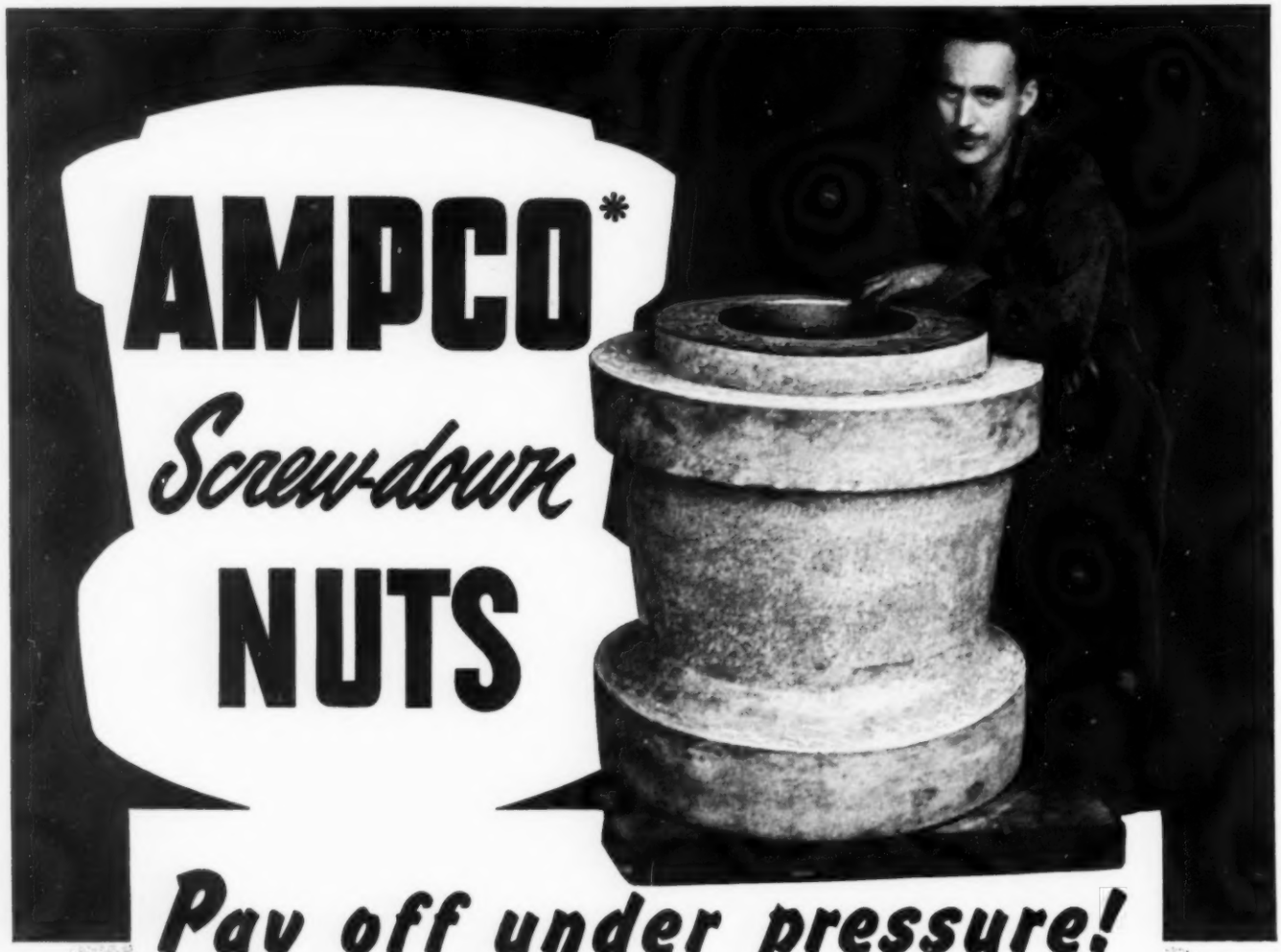
"TOOL STEEL PROCESS" PRODUCTS for steel mills also include Wheels, Rolls, Gears, etc., each carrying an absolutely positive GUARANTEE to give a longer life in the same service than any other product.

Write today for TSP Mill Pinion Bulletin 752.

ILLUSTRATED AT RIGHT ARE THREE TYPICAL STEEL MILL INSTALLATIONS WHERE "TOOL STEEL PROCESS" MILL PINIONS ARE ALSO DELIVERING OUTSTANDING PERFORMANCE RECORDS.

AD 117

FOR GEARS • PINIONS • ROLLS • WHEELS AND OTHER HARDENED PRODUCTS



Pay off under pressure!

Help maintain record-breaking tonnages by holding downtime to a minimum . . .

Tough? You bet. That's why Ampco screw-down nuts stand up under the tremendous impact and loads developed in blooming-mill operations. They pay off under pressure — keep production up, costs down.

Ampco screw-down nuts are usually centrifugally cast for the sound structure so necessary to provide the tough wear resistance you want. And you can get them in sizes up to 6000 lbs.

Ampco Metal pays off in other critical production jobs as well — providing extra toughness for wearplates, slippers, flash welder dies — and cost-saving corrosion-resistance for pickling equipment and similar applications.

Consult your nearby Ampco field engineer for complete details—he will be glad to recommend Ampco economies.

G-10

AMPCO METAL, INC.

DEPT. IS-12, MILWAUKEE 46, WISCONSIN

West Coast Plant . Burbank, California

*Reg. U. S. Pat. Off., Ampco Metal, Inc., Milwaukee, Wis.

AMPCO®

particles. A much more solid sand mass results.

The device used consists of a tube which is vibrated by an electrically driven eccentric inside it. A 10-ton centrifugal force is produced. This apparatus is attached to a follow-up pipe which houses required water and electric lines.

The complete compaction at Bonnie plant took two crews 160 days for some 3350 compactions. Results show, after six months, that one of the first structures completed, the phosphate storage building, has experienced no measurable settlement. Advance estimates had allowed for a maximum settlement here on the order of one inch.

The 38-acre plant of National Supply Co. at Torrance, Calif., generally regarded to be the largest completely integrated manufacturing plant in the West, is no place for a maintenance man to go out on a job without the right tools. So A. J. Baker, of the maintenance department, designed and built this portable tool box, with a "place for everything and everything in its place." Two wheels and its convenient handles make it easy to push, but it has three feet to enable it to stand firmly when on the job.

NEW ADDITION PLANNED BY ALUMINUM ORE CO.

▲ Plans for a proposed major addition to Aluminum Ore Co.'s new alumina works at Bauxite, Ark. were announced November 22. The new facilities would be for manufacture of finished chemical products from alumina processed from bauxite mined in Arkansas.

The plant would be built to help meet defense requirements for vital alumina chemicals. It would also be part of the ore company's long-range plans for meeting anticipated growth in civilian demands for chemicals.

The plant is to be erected on property already owned by Aluminum Ore Co., a subsidiary of Aluminum Co. of America. The site is adjacent to the alumina works which went into continuous production last month and which reaches its full capacity early next year.

NEW FURNACE ANNOUNCED BY KUTZ ENGINEERING

▲ Kutz Engineering Co., Pittsburgh, Pa., in collaboration with Fab-Cor, Inc., have announced a new and unique furnace at a recent demonstration. This furnace was designed to accommodate and heat various sized discs and cone sections prior to flanging. Thus it is possible to eliminate the coke fires normally used for heating the edges of such heavy plates. The design can also be modified so the furnace can be used as a forging, open top, slot furnace, etc.

The unit on demonstration can heat discs 15 ft in diam up to 18 in. from the edge to temperatures up to 2800 F. The furnace gives a heat release with 16-oz air of 3,750,000 Btu per hr and with 32-oz air will produce 5,000,000 Btu per hr. The burners were furnished by Bloom Engineering Co., and will give a maximum turndown greater than 10 to 1 on gas or oil. This unit can heat 650 lb of 1-in. thick steel in 30 min to 1800 F or 1650 lb per hr to 1600 F. With other tops temperatures up to 2450 F can be produced.

NATIONAL STEEL LAUNCHES ORE BOAT

▲ National Steel Corp.'s newest ore freighter, the "Ernest T. Weir," was launched November 19, at the Lorain, Ohio, yard of the American Ship Building Co. Named for National Steel's chief executive, the "Ernest T. Weir" is the largest bulk carrier ever built on the Great Lakes.

Fitting of the interior and installation of equipment will take place during the winter months, and the vessel will be ready to take her place with the other freighters in the National Steel Fleet at the beginning of the 1953 iron ore shipping season next spring.

The overall length of the new "Ernest T. Weir" is 690 ft, with a beam of 70 ft and a molded depth of 37 ft. The displacement of the ship at a draft of 25 ft, which is the maximum available in existing channels, is 21,500 gross tons, including cargo, fuel and stores. Of this weight, approximately 20,700 tons will comprise the iron ore cargo.

The ship has been designed for a maximum draft of 25 ft, 6 in., however, to take advantage of any future increase in depth of water. This will increase the carrying capacity of iron ore cargo to 21,300 tons.

IMPORTANT DATA FOUND IN GRINDING RESEARCH

▲ Valuable data on grinding, of considerable importance to both engineers and production management, are becoming available as the result of basic research being conducted at Mellon Institute by the L. Leslie Byers Memorial Fellowship sponsored by the Grinding Wheel Institute.

Currently, the research seeks to answer the question: "What happens to a surface when it is ground?" Here are some of the important results of the project to date:

1. Better techniques have been developed for studying the residual or "locked in" stresses in surfaces.

The practical importance of such stresses is that they may affect the service life of many important manufactured parts. The effect may be beneficial or detrimental, depending upon the type of stress, its magnitude and location in the part, and the forces to which the part is subjected in use.

2. Considerable information has been obtained through investigation of residual stresses in surfaces generated by abrasive action. Like all mechanical methods of generating surfaces, grinding induces residual stresses.

3. In the case of abrasive wheel grinding, these stresses may be either tensile or compressive, depending upon direction and the depth below the surface. The thickness of the stressed layer, which has varied from about two to more than 40 thousandths of an inch in experiments conducted to date, depends upon the composition of the steel, its heat treatment and the severity of the grinding. The highest stresses usually lie well within one thousandth inch of the surface in this type of grinding.

4. Lapping with loose abrasive induces compressive stresses in steel

surfaces which extend a few ten-thousandths of an inch into the metal.

5. Barrel finishing with abrasive grain induces predominantly compressive stresses in steel surfaces.

6. Preliminary studies of residual stresses in glass and plastic have shown that these materials are similar to steel in their reaction to grinding.

7. Valuable information has been accumulated concerning the residual stresses resulting from the heat treatment of steel.

Future plans call for an extension of the experiments to include methods of alleviating grinding stresses when they are detrimental, and fatigue studies to determine their effect upon service life.

Authoritative information on many practical and important aspects of grinding is available in booklet form at no cost by writing to the Grinding Wheel Institute, 2130 Keith Building, Cleveland 15, Ohio.

TOOL STEEL CELEBRATES PLANT EXPANSION

▲ Tool Steel Gear and Pinion Co. of Elmwood Place, Ohio, held an open house for employees, families, and friends on November 1 to celebrate the completion of their new plant No. 2, located just north of Sharonville, Ohio, on route 25. LeRoy R. Brooks, president, announced that the increased facilities at both the old and the new plant were intended to increase production 30 per cent and it was the largest expansion program in the history of the company since the firm was founded in 1909. The new plant houses principally gear cutting equipment with some special steel heat treating facilities. It covers an area of 30,000 sq ft and the total cost of the expansion program was approximately $1,500,000.

The officers of the company are: Leroy Brooks, Jr., chairman of the board; LeRoy R. Brooks, president; Sanford M. Brooks, executive vice president and secretary; C. R. Burrell, vice president in charge of sales; Harry M. Hopkins, vice president of operations; J. J. Stolz, assistant vice president, engineering; N. C. Strohmenger, assistant vice president, metallurgy; Stanley Woodward, treasurer; Carl Buse, assistant treasurer; and R. G. Weithorn, assistant secretary.

WESTINGHOUSE RECEIVES WEIRTON CONTRACT

▲ Westinghouse Electric Corp. recently announced receipt of a $572,000 order from the Weirton Steel Co. for additions to an electrolytic tinning line that was installed in 1949.

The line has a maximum speed of 2000 fpm and uses high-frequency radio waves to "reflow" the tin and provide a glossy surface.

For use in extending facilities for operation at higher speeds or for increasing the thickness of the tin coating, Weirton will install an additional plating generator rated at 600 kw. The Westinghouse order includes the 600-kw r-f generator, two switchgear units, a transformer, and seven 1250-hp synchronous motors.

ATLANTIC STEEL CO. HOLDS OPEN HOUSE

▲ More than 12,000 people visited the new Warehouse division facilities of Atlantic Steel Co., Atlanta, Ga., during the two-day open house on October 31 and November 1.

Company executives greeted guests as they entered the new air conditioned office which was banked with flowers sent by suppliers and friends of the company. From the stainless steel-covered registration counter, yellow lines and directional arrows marked the travel route throughout the building. Hostesses and guides were stationed at strategic locations to answer visitors' inquiries.

Atlantic Steel inspection personnel and laboratory technicians demonstrated the use of Rockwell machines and magnetic comparators in determining the hardness and identification of steel. "Safety with Production" was the theme of Atlantic Steel Co.'s safety exhibit, where protective equipment and the current mill safety campaign were integral parts of the colorful display.

Open House guests also visited Atlantic Steel's new electric melt shop and got a close-up view of the South's largest electric furnace from charge to tap. A fleet of cars shuttled visitors back and forth from the warehouse to the new 60-ton electric furnace operation.

Not only was the crowd large, but it was well represented by all groups. Many employees brought their families; officials of colleges and schools were present; and leaders from industry, commerce and business attended the show with enthusiastic interest. High school and college student groups enjoyed a complete visit, as did many scout troups.

The new home of the Atlantic Steel Co.'s warehouse division, costing in excess of $500,000, is one of the most modern steel warehouses in the nation. Covering 64,400 sq ft, the 45-ft high structural steel building is 460 ft long and 143 ft wide — larger than a football field. The entire reinforced concrete floor area is on one level. The largest lighting and heating facilities were installed to insure safe and comfortable working conditions.

KAYDON ENGINEERING ADDS NEW DIVISION

▲ The purchase of A. Harold Frauenthal, Inc., by Kaydon Engineering Corp., Muskegon, Mich., has been announced. The Frauenthal Division of Kaydon will contine to operate.

In steel mill tradition, the boss lights up cigars for steel men as 45-in. slabbing mill at U. S. Steel's Homestead, Pa., plant rings up a world's record for one month's output — 214,842 tons in October. Albert Kern, Thomas O'Brien, and William Selleman, heater, roller and shearman respectively, get lights from C. J. Fleisch, assistant general superintendent.

Mr. Steel Producer:

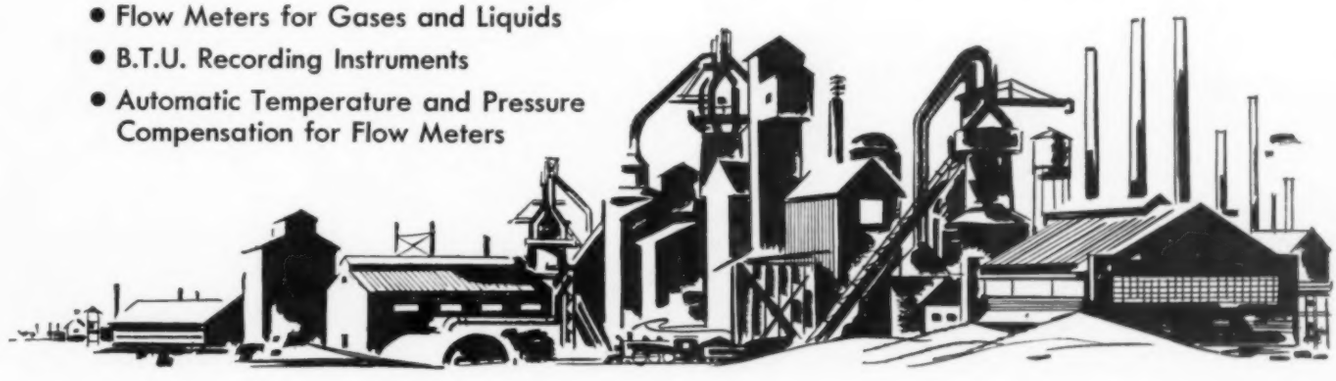
HAGAN AIR-OPERATED CONTROLS and RING BALANCE FLOW METERS give you reliability in control and metering for every steel mill application...

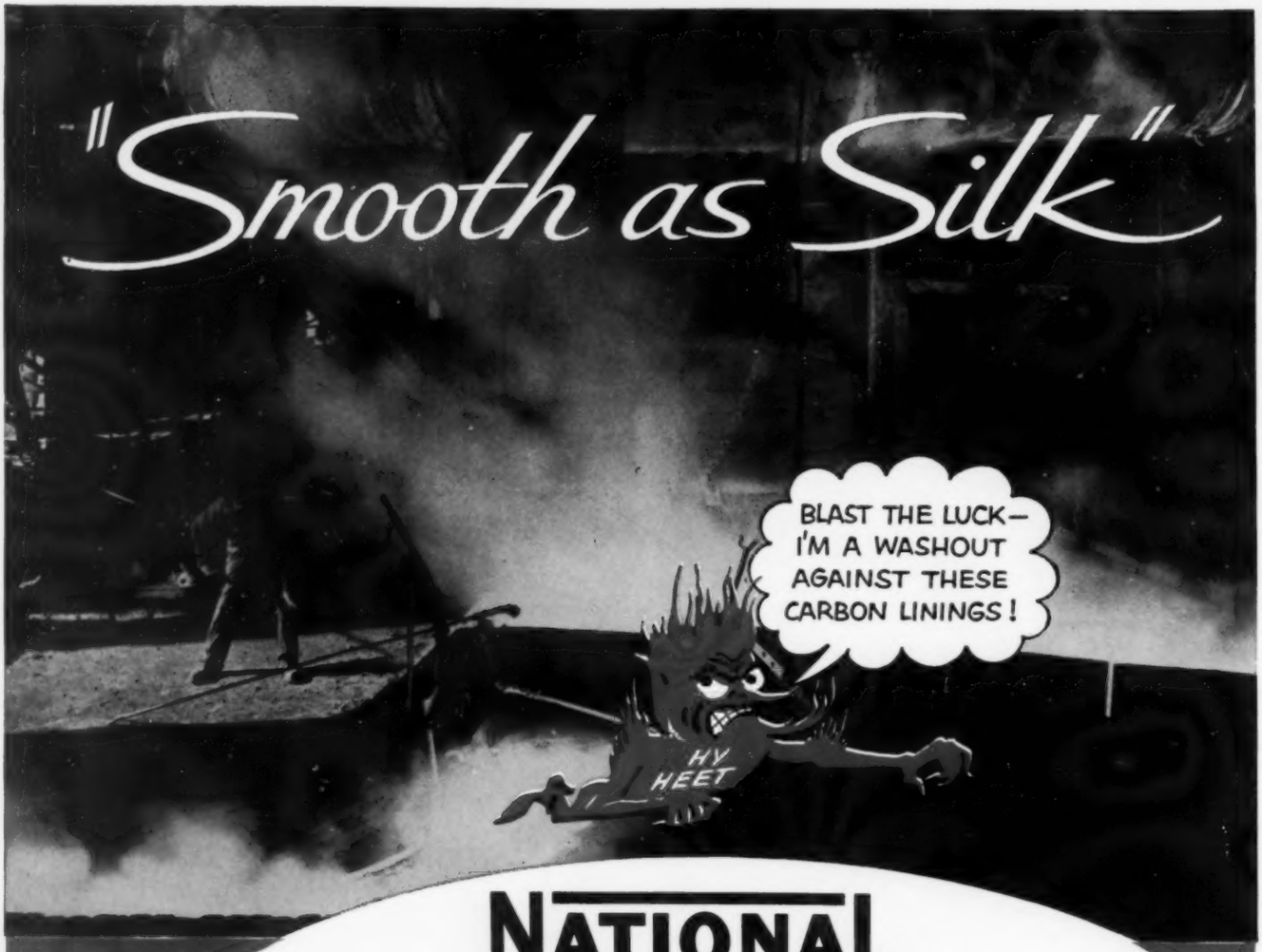
- Total Heat Input Control
- Fuel-Air Ratio Control
- Furnace Pressure Control
- Gas Pressure Control
- Gas or Air Flow Control
- Gas Mixing Station Control
- Furnace Reversal Control
- Multiple Fuel Firing Control
- Draft and Pressure Recording Instruments
- Flow Meters for Gases and Liquids
- B.T.U. Recording Instruments
- Automatic Temperature and Pressure Compensation for Flow Meters

You can depend on Hagan Air-Operated Controls and Ring Balance Flow Meters for these services—and many more. Hagan Control and Instruments are specifically designed for each exacting job in your plant. For reliable metering and control systems, fitted to your needs, write, wire or phone:

HAGAN CORPORATION

HAGAN BUILDING PITTSBURGH 30, PA.





NATIONAL
TRADE-MARK

CARBON-LINED BLAST FURNACES

TYPICAL of the many comments favoring carbon-lined furnaces after the recent strike, was that made by the manager of a large eastern mill.

Describing his carbon hearths as coming back on blast "smooth as silk", he joins the many other users reporting faster, easier, more economical return to normal operation with carbon lined furnaces than with any other type of lining.

MORE THAN 30% OF ALL U. S. BLAST FURNACES ARE NOW LINED WITH "NATIONAL" CARBON!

The terms "National" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
IN CANADA: National Carbon Limited, Montreal, Toronto, Winnipeg

DOLLARS and SENSE...

point to "Eveready" No. 1050 Industrial Flashlight Batteries . . . delivering twice as much usable light as any battery we've ever made before. Their unique construction prevents swelling or jamming in the case . . . has no metal can to leak or corrode.

OTHER NATIONAL CARBON PRODUCTS

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • ELECTRIC FURNACE ELECTRODES • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS

Personnel News...

Clifford F. Hood was elected president of the United States Steel Corp. effective on January 1, 1953, and a member of the board of directors effective immediately. He also becomes a member of the finance committee. Mr. Fairless will continue as chairman of the board and chief executive officer of the corporation. **Robert C. Tyson** was elected vice chairman of the finance committee and a member of the board of directors and of the finance committee of the corporation, effective immediately. He will also continue as comptroller. **Harvey B. Jordan** was elected executive vice president-operations of the corporation. **Walter F. Munford** was appointed president of the American Steel & Wire division of United States Steel. **Howard E. Isham** was elected vice president and treasurer of the corporation effective on December 1, 1952. He will succeed **Max D. Howell,** who will retire from these posts on November 30, 1952. As previously announced, United States Steel Co. will be merged into the United States Steel Corp. effective at the beginning of 1953, when the parent company will become primarily an operating company.

Harry L. Jenter has been appointed to the position of assistant district manager for the Cleveland, Ohio, district of American Steel & Wire Division of U. S. Steel Co. Mr. Jenter was chief engineer of the wire division prior to his promotion. In his new post he will be concerned with the operations of wire division facilities in this area, including Cuyahoga Works, American Works, Central Furnaces and Docks and Coke Works, and Newburgh Works. **Floyd A. Garman** has been named chief engineer and **Walter V. Magee** assistant chief engineer of American Steel and Wire Division of United States Steel Co. Mr. Garman succeeds Mr. Jenter, who was promoted to assistant manager of operations of the Cleveland district. He began with American Steel and Wire in 1935 as a draftsman. After several promotions he was named works engineer in the wire division's South Works in Worcester, Mass., in 1944. Three years later he was made superintendent of engineering and maintenance. He returned to the Cleveland office as projects division engineer in January, 1949, becoming assistant chief engineer on August 1, 1950, a position he has held until now. Mr. Magee's first job with United States Steel was that of draftsman for National Tube division in Wheeling, W. Va., in 1925. Subsequently, he held similar positions with Tennessee Coal & Iron Division in Ensley, Ala., before becoming a draftsman for American Steel & Wire in Cleveland in 1927. After several promotions he became construction engineer in the engineering department in Cleveland. He was named division engineer-construction on April 1, 1945, a position he has held until now. Mr. Magee is chairman of the Cleveland-Youngstown Section of the Association of Iron and Steel Engineers.

Frank E. Myers, vice president of operations has been placed in charge of operations of Salem-Brosius, Inc., Pittsburgh, Pa. Mr. Myers has been vice president of the company since it was formed in 1950 by the consolidation of the Edgar E. Brosius Co., Pittsburgh, and the Salem Engineering Co., Salem, Ohio. **Thomas E. Lloyd,** formerly assistant to the president, has been named manager of sales of Salem-Brosius, Inc., and will direct sales activities of all phases of the company. **Carl J. Westling** has been appointed chief engineer, Salem-Brosius, Inc., and will be in charge of the centralization of all engineering activities, including research and development. **Walter H. Scheib** has been appointed manager of foreign operations and will head up all foreign operating and sales activities, including the functions of Salem Engineering Co., Ltd., England. **John R. Wickwire** has been named assistant to the vice president, operations, and will be in charge of all personnel activities of the company. **S. T. Morgan** has been appointed manager of operations, Brosius Division of Salem-Brosius, Inc., and will head all manufacturing functions of this division.

Fred Whittier has been promoted to supervisor of bituminous coatings research and development department, Pittsburgh Coke and Chemical Corp., Pittsburgh, Pa. Mr. Whittier had been supervisor of coal tar chemical process improvement in the production department.

CLIFFORD F. HOOD

HARVEY B. JORDAN

WALTER F. MUNFORD

WALTER V. MAGEE

Announcing

F&Y CONTINUOUS STRIP PICKLING LINE

NEW · EFFICIENT · ECONOMICAL

Complete line equipment with latest improved operating features. Maximum volume production with minimum floor space requirements.

If you are interested in a new installation or improving your present equipment why not investigate the Youngstown Line!

these features

- ☐ Coil Box with Strip Opener.
- ☐ Triple Processor with Roller Leveller.
- ☐ Flash Welding and Mechanical Stitching.
- ☐ Single Cycle Up-Cut Shears.
- ☐ Heavy Duty Rubber Covered, Brick Lined Steel Tanks.
- ☐ Magnetic Loop Control for Acid Tanks.
- ☐ Fume Exhaust System—Roto Clone Scrubber.
- ☐ Automatic Control System for Temperature and Acid Proportioning.
- ☐ Side Trimmer with Scrap Cutting or Balling.
- ☐ Up-Coiler with Strip Oiling System.
- ☐ Entry and Exit Coil Conveyors.

The Youngstown Foundry & Machine Co. F&Y

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

9

E. Woodward Allen has been elected vice president of Thomas A. Edison, Inc. In his new capacity, Mr. Allen will serve as assistant to the vice president and manager of the company's Storage Battery Division.

F. WOODWARD ALLEN

James F. Bishop, in addition to his corporate duties of secretary-treasurer, has been appointed general manager of American Hoist and Derrick Co., St. Paul, Minn.

J. G. Baldwin was named regional sales representative for Trabon Engineering Corp. in Georgia. Mr. Baldwin has been in charge of the industrial lubrication departments of two major oil companies for the past 15 years. Mr. Baldwin will make his headquarters in Atlanta.

G. Krause has been appointed chief designer of Loewy Construction Co., subsidiary of Hydropress, Inc., New York, N. Y.

William Strickland, sales engineer for Timken Roller Bearing Co. has been transferred from the Houston, Tex., to the Detroit, Mich., offices of that company.

WILLIAM STRICKLAND

John E. Munn has been appointed development engineer for Oliver Iron and Steel Corp., Pittsburgh, Pa.

30% Less Space
Same High Capacity
IN NEW
LINTERN
MODEL 531
CAB UNIT

The new Lintern Model 531 CAH Cab Unit now available with the Lintern Aire-Rectifier for hot metal cranes furnishes comfortable year 'round air conditioning — with greater visibility than ever.

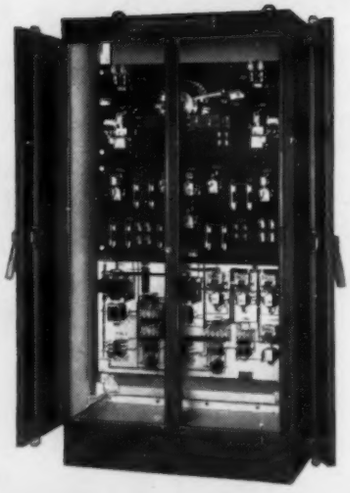
Dimensions have been cut down to 36″ H. x 17″ D. x 28″ W. Thirty per cent less space required!

Performance characteristics are of the same high standards as in previous models, providing three capacities, 14,000 b.t.u., 18,000 b.t.u. and 27,000 b.t.u. at 140° F. The quiet blower allows for complete air direction and deflection as the operator desires. The unit maintains the cab at a cool, comfortable 80-85° F. in ambient temperatures up to 180° F. and filters the air of dusts and waste gases.

THE LINTERN CORPORATION
P. O. Box 428 • Painesville, Ohio

SQUARE D
FIELD ENGINEERING
in Action!

PROBLEM To design a panel that would automatically control, sequence and indicate the progress of the entire charging operation for this #2 blast furnace located at the Clairton Works of United States Steel Company.



SOLUTION

Square D designed and built this simple and easily maintained master panel to control and sequence existing motor starters—utilizing standard components from Square D's complete line of heavy duty equipment. One man now controls the entire charging operation from a master station . . . a typical example of Square D field engineering in action — conserving materials, time and effort while increasing the factor of safety.

SQUARE D FIELD ENGINEERS ARE AT YOUR SERVICE
THROUGH BRANCH OFFICES IN ALL PRINCIPAL CITIES

SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

SQUARE D COMPANY CANADA LTD., TORONTO • SQUARE D de MEXICO, S. A., MEXICO CITY, D. F.

J. David Wright, a veteran of 43 years in engineering electrical systems for industry, retired from the General Electric Co., October 31. Mr. Wright joined G.E. in 1909 as a student engineer on the company's test course, and in 1910 was assigned to the industrial control engineering department where he worked on control applications for industrial processes. Transferred to the steel mill section of the power and mining engineering department in 1915, Mr. Wright became head of that section in 1922. He was appointed assistant engineer of the industrial engineering department in 1930. Six years later, he was named assistant manager of the industrial department, and became manager of the industrial engineering divisions in 1940. In 1950 Mr. Wright assumed the position of assistant manager of the industry engineering and sales department, the post he held at the time of his retirement.

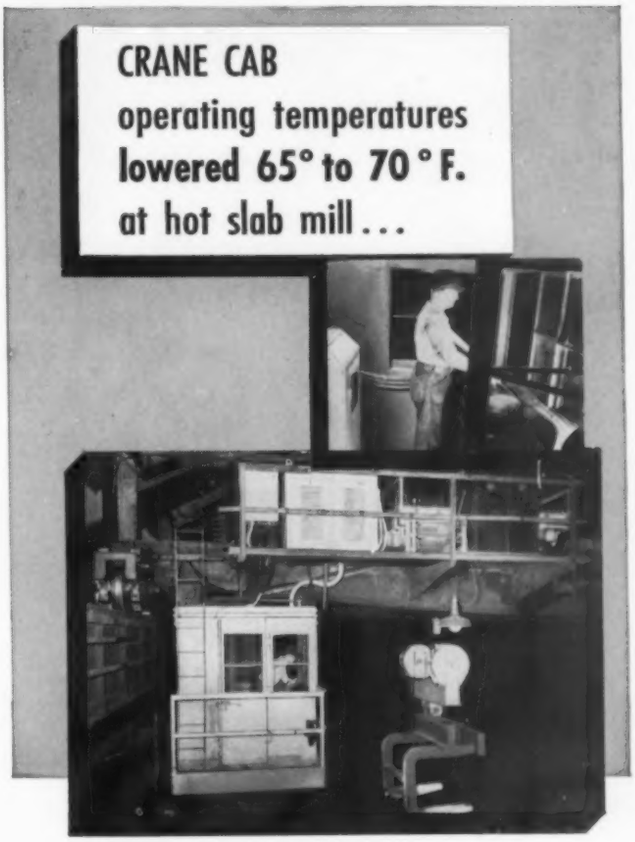
James H. Taylor has been appointed chief electrical engineer of United Engineering and Foundry Co. Mr. Taylor has been with United since 1937. From 1947 to 1951 he was in Europe as consultant electrical engineer

JAMES H. TAYLOR

for United with most of his services in connection with engineering and installation of United slabbing and 80-in. hot strip mills and cold mills for Steel Co. of Wales.

William C. McConnell, Jr., sales engineer operating out of Reliance Electric and Engineering Co.'s Detroit, Mich., office for the past several years, and previously assigned to the company's Pittsburgh, Pa., and Charleston, W. Va., territories, has been moved to Cleveland to head up Reliance a-c motor sales. **Robert B. Reed**, sales engineer in Birmingham, Ala., for the past three years, moves up to Detroit to take over Mr. McConnell's former sales engineering duties. **Rex T. Willard**, of the Atlanta, Ga., sales office, replaces Mr. Reed in the Birmingham area.

J. E. Mullen, former vice president in charge of sales at National Erie Corp., has been appointed regional sales representative in Ohio and Pennsylvania for Brad Foote Gear Works, Inc., Chicago, Ill. Mr. Mullen has been a prominent figure in the steel industry for over



DRAVO SPLIT-TYPE CRANE CAB COOLER INSTALLED AT PITTSBURGH STEEL CO.

Hot slab mill operations produce ambient temperatures in summer of 150° F., creating a major working hazard for crane operators working over these "hot spots."

Pittsburgh Steel Company at Monessen, Pa., eliminated this hazard with a Dravo split-type Crane Cab Cooler. With the condenser section mounted on the crane and the conditioning section in the cab, crane cab temperatures are kept at 80° to 85° F. regardless of sudden temperature changes outside. Crane operators are healthier, more alert and more efficient.

CRANE CAB COOLERS PROVIDE YEAR-'ROUND AIR CONDITIONING

Dravo Crane Cab Coolers are ruggedly constructed, factory assembled and pre-tested to provide years of more-than-satisfactory service. All equipment in the unit is readily accessible with ample space for quick and efficient maintenance.

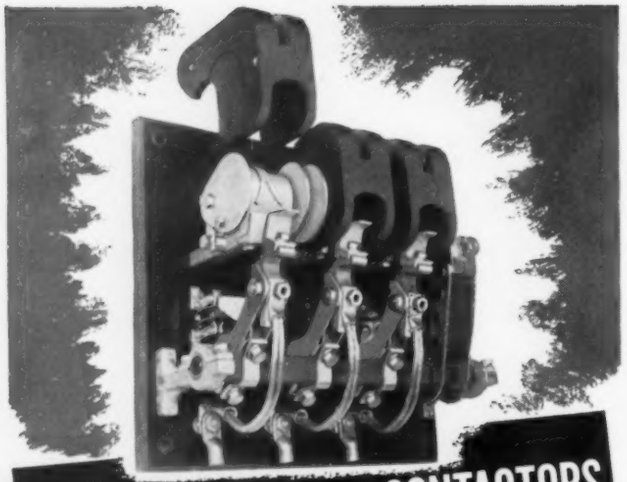
In the various air conditioning functions the crane cab cooler not only filters the air, removes dust, dirt and fumes, but heats the cab in winter, cools it in summer and provides constant ventilation the year around.

AVAILABLE IN SINGLE UNIT OR IN SPLIT-TYPE UNIT: IMMEDIATE DELIVERY

Dravo Crane Cab Coolers are built in two models—the self-contained unit, mounted on any available space on the crane and the new split-type unit where the condenser section is mounted on the crane, with the conditioning section in cab.

The Dravo Crane Cab Cooler can be easily and quickly installed on any type of crane with a minimum of down-time required. Units are available now! Write for more information—or phone the nearest Dravo Office and have our representative call on you.

DRAVO
CORPORATION
602 Dravo Building, Fifth and Liberty Avenues, Pittsburgh 22, Pa.
PITTSBURGH • ATLANTA • BOSTON • CHICAGO • CLEVELAND
DETROIT • NEW YORK • PHILADELPHIA



MAKE SURE YOUR A-C CONTACTORS PASS THIS TEST

	E.E. Contactors	Other Contactors
1 Stamped-steel, welded construction assures extra strength.	✔	
2 Light-weight, fast-moving parts provide quick operation. No die-cast parts	✔	
3 Self-lubricating, porous-bronze bearings.	✔	
4 Extra-wide, heavy-duty contacts (¾").	✔	
5 Compact design . . . lessens required mounting space	✔	
6 Lift-off arc shields for quick contact inspection.	✔	
7 Standard electrical interlock has n.o. and n.c. contacts - electrically separate	✔	
8 Stainless-steel springs on both main and auxiliary contacts.	✔	
9 Arc-centering design . . . assures longer arc-shield life.	✔	
10 Unusually high rupturing capacity. Highly efficient blow-out system.	✔	

Make these ten, top-priority features the guideposts in selecting A-C Contactors. You'll find Euclid Electric Contactors thrive on comparison because *only* Euclid offers all ten. *Plus* sound design, *plus* precision workmanship, *plus* 30 years of experience that make E.E. the leader in motor-control apparatus.

Ask your E.E. Representative for more information, or write:

The Euclid Electric & Mfg. Co.
MADISON, OHIO

forty years. In 1925 he was named assistant to the president of the Nuttall Works of Westinghouse Electric

J. E. MULLEN

Corp. and in 1950 was vice president of the Steel Founder's Society of America. He also served on the executive committee of the American Gear Manufacturer's Association.

Louis T. Barry has returned to Electric Service Manufacturing Co., Philadelphia, Pa., as manager of the company's industrial division after 17 month's service with the United States air force. He was recalled to active duty as a colonel in May, 1951. While with the air force, Mr. Barry served as deputy chief of the Aircraft and Equipment Division at Air Material Headquarters, Wright-Patterson Air Base, Ohio. Mr. Barry has been with Electric Service for 32 years.

W. P. Getty was appointed general manager of steel works, Jones and Laughlin Steel Corp., Pittsburgh, Pa. **C. C. Henning** was appointed general manager of ore mines and quarries; and **E. R. Cooper** was named general manager of coal mines. Mr. Getty was formerly assistant to executive vice president-production and is a veteran of more than 16 years of service with J&L. He started with the company in August, 1936, as an inspector in the metallurgical department at J&L's Pittsburgh Works. Mr. Getty served in various capacities in the metallurgical department until 1945 when he was appointed assistant to the general manager of raw materials. A year later he was named assistant general manager of raw materials and in 1951 he was made assistant to vice president-operations. Early in January, 1952, he was named assistant to executive vice president-production, the position he held at the time of his recent promotion.

Mr. Henning was formerly general manager of raw materials. Mr. Cooper was formerly manager of coal mines and made his headquarters at the mines offices in California, Pa.

John B. Craig has been appointed director of purchases, American Bridge Division, U. S. Steel Co. Mr. Craig succeeds **Dan Hammerschmidt**, who has retired after fifty-two years of service with American Bridge. Mr. Craig was first employed at the company's Am-

bridge plant in 1929 as a clerk. In 1944, he was named assistant to purchasing agent, and assistant purchasing agent in 1951, the position he held at the time of his present appointment. Mr. Hammerschmidt began with the company as an office boy in 1900 and had been purchasing agent for the past nineteen years.

W. G. Hoffman has been appointed West Coast representative for Aetna-Standard Engineering Co., with offices located in San Mateo, Calif. In January, 1936, Mr. Hoffman was appointed superintendent of construction of the Gary sheet mill, Gary, Ind. In July of the same year he became chief engineer at Gary. Mr. Hoffman was appointed division superintendent of the Gary tin mill division in January, 1939, and in March, 1948, he went to the Pittsburgh, Pa., office of the former Carnegie-Illinois Corp., where he was placed in charge of properties. November, 1950, he was made chief of staff of operation consulting engineering bureau. He served in this capacity until his retirement in 1951, completing a 50-year service record with U. S. Steel.

Paul R. Rauch has been appointed assistant chief inspector for the Youngstown district of Youngstown Sheet and Tube Co., Youngstown, Ohio. His offices are at the Campbell plant.

McAndrew McCall has been named chief design engineer, construction department, Machinery Division, Dravo Corp., Pittsburgh, Pa. Mr. McCall has held

McANDREW McCALL

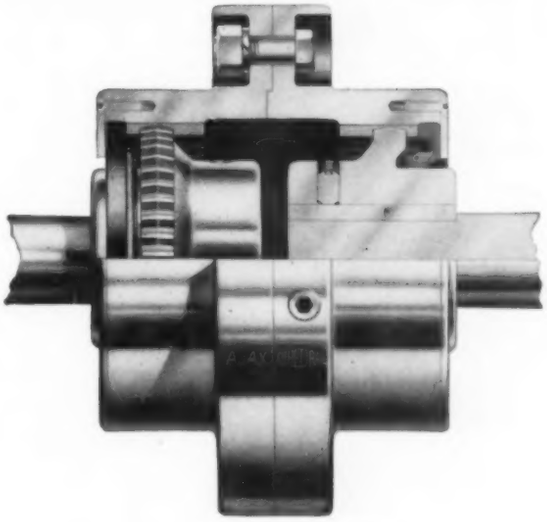
various engineering positions throughout the world. His last position was that of chief engineer and general superintendent of Compania Tecnica y Constructora in Mexico and South America.

Charles Carr, Sr., was named manager of the steel works department, Weirton Steel Co., Weirton, W. Va., to succeed **P. R. Church**, who has retired. **William McGarrity**, assistant to the manager of the steel works, was made assistant manager of the steel works. **Robert Allard**, superintendent of the blooming mill, was pro-

(*Please turn to Page 202*)

AJAX DIHEDRAL

New Coupling STEEL MEN Have Waited For



▶ Ability of Ajax Dihedral Couplings to handle extreme misalignment is the talk of hard-boiled steel men everywhere.

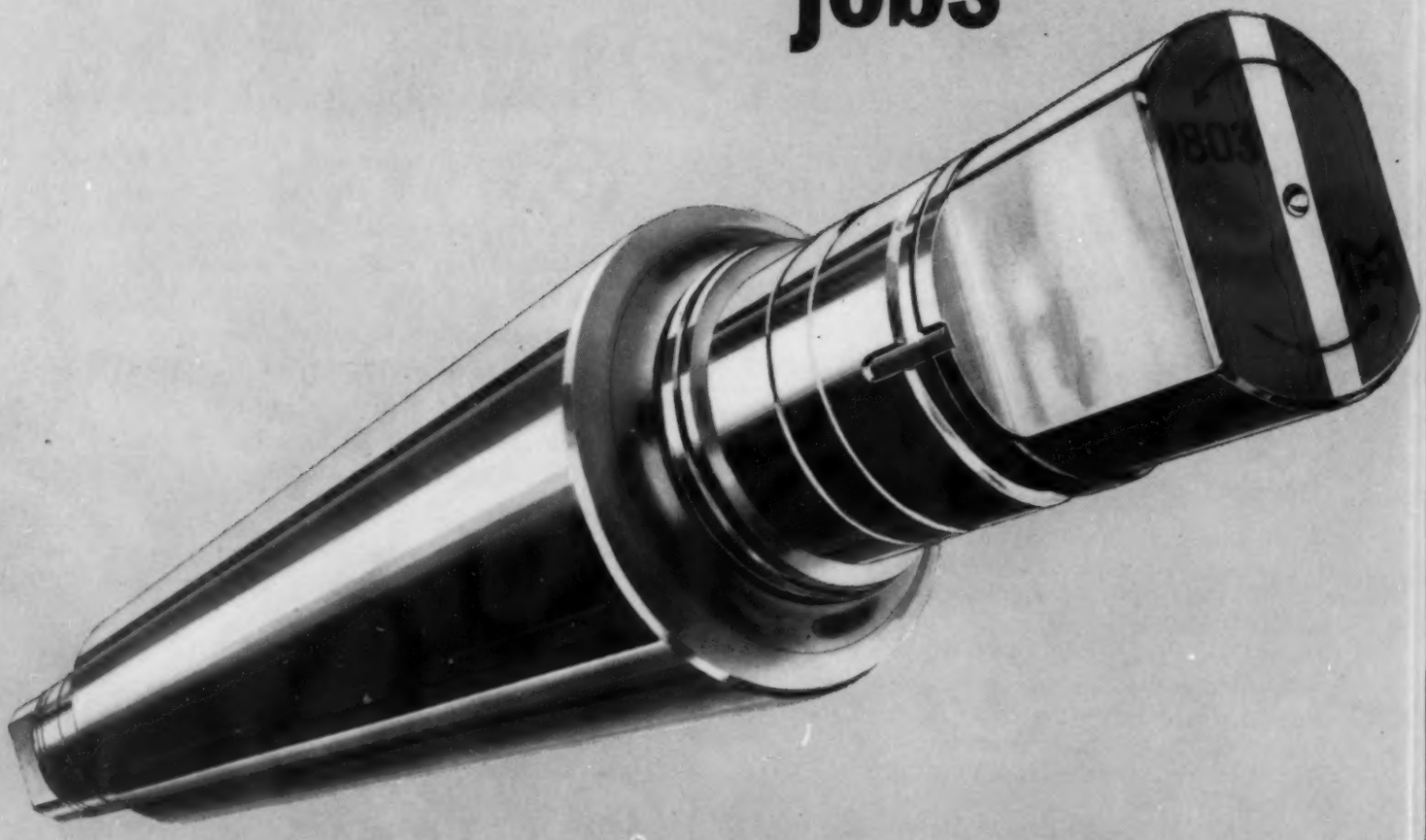
Exclusive Dihedral tooth shape provides for misalignment up to 4 degrees as stock off-the-shelf couplings. 6, 8, 10 and 12 degree teeth cut to order.

Save costly hours of setup, change-over and maintenance time. Line up motors in minutes not hours.

Write for facts on this radically new and exclusive coupling.

AJAX FLEXIBLE COUPLING CO. INC.
WESTFIELD, NEW YORK

for your rolling mill jobs



there are MACK-HEMP ROLLS developed to do them best

How?

Because *your* roll designers and mill operators have helped Mack-Hemp metallurgists in the development of our rolls, the rolls *with the striped red wabblers* turn in excellent production records.

For example, application of Mack-Hemp rolls in intermediate stands on high speed strip mills reduce costly down-time, because Mack-Hemp rolls stay in the mill longer without redressing.

Because we are working constantly to improve the rolls *with the striped red wabblers,* it's wise to keep your eye on what's new at Mack-Hemp.

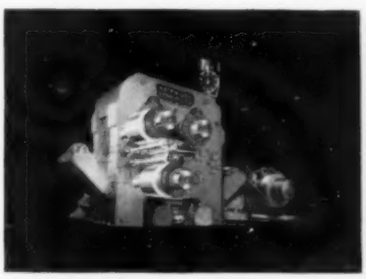
1952...

Mack-Hemp's one hundred fiftieth year of continuous product improvement

MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

Makers of the Rolls with the Striped Red Wabblers



Mack-Hemp makes modern equipment for steel mills:

Y-MILLS

Modern Mack-Hemp Y-Mill is the reversing cold strip mill which combines the advantages of small diameter rolls, power for high speed and deep draft in a compact, simple arrangement.

ROTARY STRAIGHTENERS

Mack-Hemp Rotary Straighteners straighten end-to-end to precision tolerances, and finish with no guide marks or scoring. They cut costs and insure quality of straightened product.

JOHNSTON CINDER POTS

Johnston Patented Cinder Pots are designed to fit your plant requirements. From small units for electric furnace use to giant thimbles for blast furnace and open hearth, Johnston Cinder Pots provide dependable slag disposal service.

Because Mack-Hemp engineers keep pace with modern steel mill practice, it's wise to keep your eye on what's new at Mack-Hemp.

moted to the position left vacant by the advancement of Mr. McGarrity.

George H. Anthony has joined Youngstown Sheet and Tube Co. as ceramic engineer in the mill research and development department. His office is located in the laboratory building at the Campbell, Ohio plant.

Obituaries

Leopold E. Block, 83, one of the founders of Inland Steel Co., Chicago, Ill., died November 11. Mr. Block is credited with having handled the complex financial affairs of Inland Steel Co. in its growth to seventh largest steel company in the nation from a $65,000 company which took over a small rail re-rolling mill that had been bankrupt by the depression of 1893. Mr. Block was vice president of the company from 1897 to 1919 when he became chairman of the board.

Arthur K. Higgins, 44, an assistant director of research of Allis-Chalmers Manufacturing Co., Milwaukee, Wisc., died November 6.

Paul B. Morgan, 83, chairman of the board, Morgan Construction Co., Worcester, Mass., died November 3.

Robert Harkness Ellis, manager of the electrical, service and construction departments for United Engineering and Foundry Co., Pittsburgh, Pa., died November 1.

Heroult

ELECTRIC MELTING FURNACE

. . . as ever, the dependable furnace for the production of high-grade stainless, alloy and rimming steels.

Removable roof of new design now available for the larger furnaces.

AMERICAN BRIDGE DIVISION
UNITED STATES STEEL COMPANY
General Offices: 525 William Penn Place, Pittsburgh, Pa.
Contracting Offices in New York, Philadelphia, Chicago, San Francisco and other principal cities

USS AMERICAN BRIDGE
UNITED STATES STEEL

Amsco Chains Get Tougher With Use

How AMSCO Manganese Steel Chains Acquire Progressively Greater Resistance to Impact and Abrasion.

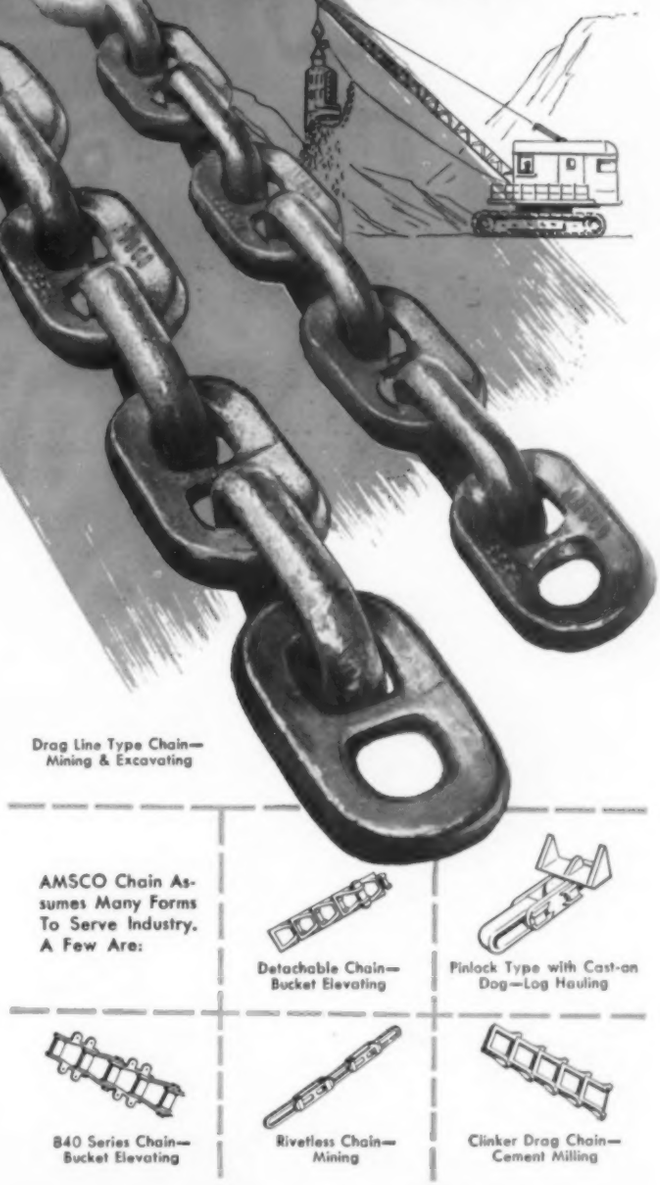
Actual case histories prove that AMSCO Manganese Chains outlast ordinary chains by more than 6 to 1 where impact and abrasion exist. For example, on one conveyor operation, ordinary chain had to be completely replaced every three months. When AMSCO Manganese Steel Chain was installed, only a small fraction of the links were replaced during a test period of over 24 months.

Users of AMSCO Chains benefit by unusual freedom from expensive chain replacement, breakage, maintenance-down-time and other problems caused by impact and abrasion conditions.

AMSCO Manganese Steel Chains have the unique ability to work-harden with use. In rough service, they develop a surface hardness up to 500 Brinell. They also acquire a hard glass-like polish that helps shrug off grinding abrasion. All AMSCO Manganese Steel products — tough when produced — possess the extra-value quality of actually increasing durability with in-use battering and grinding.

AMSCO Chains are made of Manganese Steel —the "Toughest Steel Known." They are produced in many standard and special shapes by American Manganese Steel Division—largest producer of manganese steel for all industry.

If you use chain, and desire a more durable alloy, you are invited to contact AMSCO. There's a good chance we can save you money and provide chains that will outlast your service life expectations.

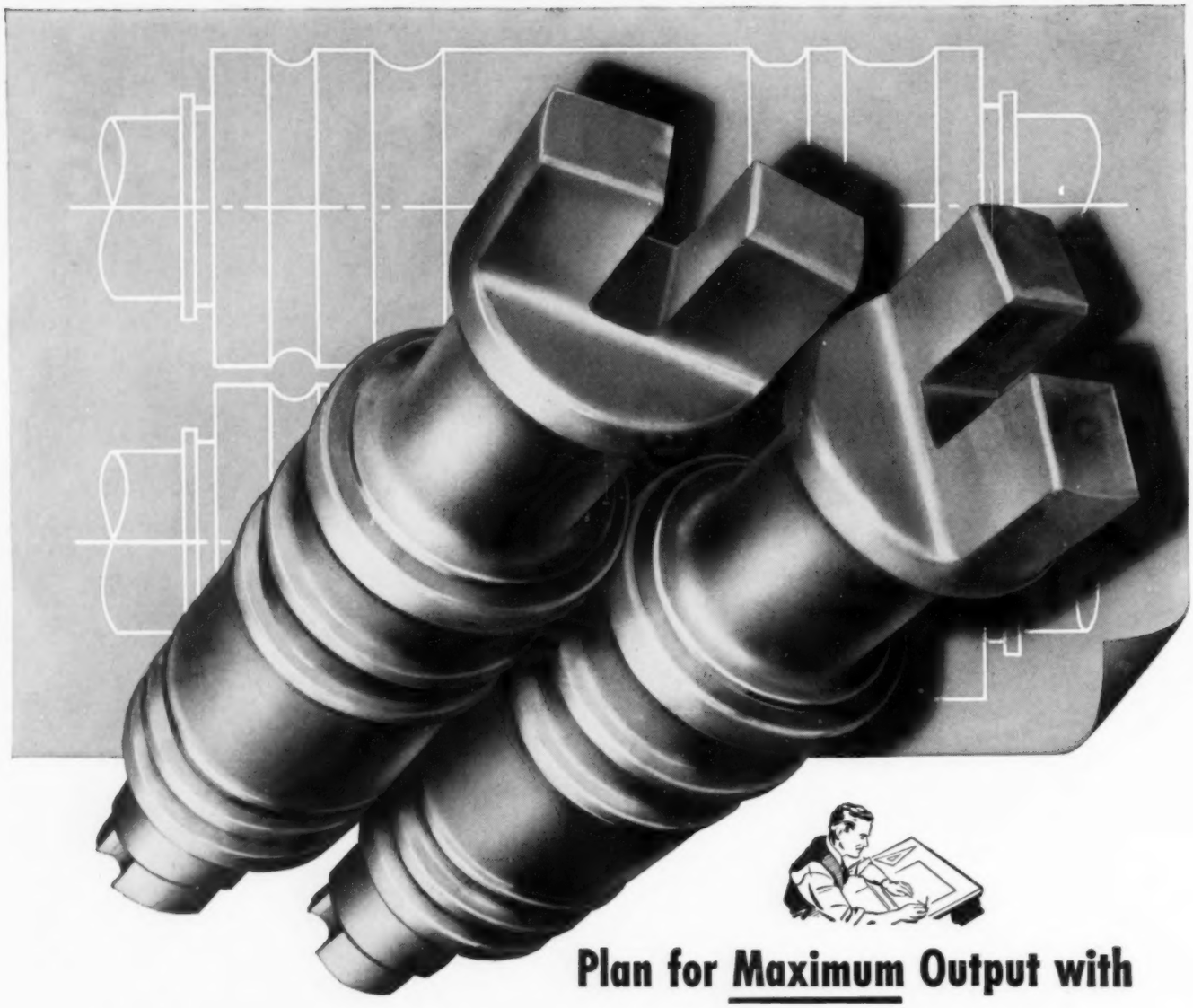

Drag Line Type Chain—Mining & Excavating
AMSCO Chain Assumes Many Forms To Serve Industry. A Few Are:
Detachable Chain—Bucket Elevating
Pinlock Type with Cast-on Dog—Log Hauling
840 Series Chain—Bucket Elevating
Rivetless Chain—Mining
Clinker Drag Chain—Cement Milling

AMERICAN Brake Shoe COMPANY

AMERICAN MANGANESE STEEL DIVISION

411 EAST 14th STREET • CHICAGO HEIGHTS, ILL.

Other Plants: New Castle, Del., Denver, Oakland, Cal., Los Angeles, St. Louis. In Canada: Joliette Steel Division, Joliette, Que.
Amsco Welding Products distributed in Canada by Canadian Liquid Air Co., Ltd.



Plan for Maximum Output with

BIRDSBORO ROLLS

When mill rolls are blueprinted and engineered to meet your specific requirements, you're more sure of getting the results you want. That's why you can *expect more*—and get it—from Birdsboro Rolls.

From basic design, through painstaking analysis control, to final installation, mill roll "tailoring" like this may well be your answer to higher production at a lower cost per ton.

Whether you're rolling alloy, stainless, high speed steels, or steels for advanced applications, the wide selection of Birdsboro Rolls assures you long-range rolling efficiency . . . greater freedom from maintenance and non-productive time. A Birdsboro Representative will be glad to be of assistance on any of your mill roll problems.

Offices in:
BIRDSBORO, PA.
AND
PITTSBURGH, PA.

BIRDSBORO
STEEL FOUNDRY & MACHINE CO.
Birdsboro, Penna.

ROLLS

Designers and Builders of:
Rolls • Crushing Machinery • Steel Mill Machinery
Hydraulic Presses • Special Machinery • Steel Castings

RA 9-52

Publication Service...

DECEMBER, 1952

You Can Obtain...

... any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

(1) Split Roller Bearings

Literature is available describing Cooper split roller bearings which are made in halves throughout and are, therefore, extremely simple and rapid to install and maintain. The usual advantages of anti-friction roller bearings, namely easy starting, power-saving, reduction in cost of lubrication, compactness of design, elimination of wear, long life, etc., are now widely recognized, but by reason of the unique split feature these roller bearings offer important and additional advantages, which merit the consideration of every steel mill engineer and operator. Cooper Roller Bearings Co., Ltd.

(2) Primary Batteries

A new catalog section has been announced covering a line of copper oxide-caustic soda primary batteries for railroad signal service, low voltage switch machine operation, slide protection and communications. Described in the catalog is a new 1000-ampere-hour copper oxide signal cell. This cell, designated as the "Eveready" Type 5-1000 standard voltage cell, is classified as Type A, Class 5, under Signal Section, Association of American Railroad, Specification No. 87-39. Fully guaranteed to meet this specification, the cell has a simple rectangular flat plate design with 3 zinc plates and 2 copper oxide plates. Of exceptional strength, the entire rugged assembly was developed to provide high uniform quality and dependable performance. The "Eveready" Type 5-500 and 3-500 and the "Columbia" high voltage Type 572 are also described and illustrated in the catalog section, which also contains a physical data chart and maximum discharge chart for each type cell. The construction, operation, renewal element and recommended service is fully explained for each signal cell. (R-9500). National Carbon Co.

(3) Bearing Mountings

Available to steel mill engineers and operating executives is a new rolling mill equipment section to the Timken Engineering journal. This is the first time in the history of the anti-friction bearing industry that an engineering journal supplement has been prepared covering the mounting of tapered roller bearings in all types of rolling mill equipment. In preparation for more than a year, this reference book contains more than 265 pages and over 400 design illustrations. It is divided into nine basic parts. Timken Roller Bearing Co.

(4) Magnetic Regulators

Application of the "Magamp" regulator to the various control problems found in steel mill processes is discussed in a new 19-page booklet available to you. A magnetic device for amplifying voltage and current, the "Magamp" consists of an iron core with an a-c output winding and one or more d-c control windings. Basically, it introduces variable impedance into an a-c circuit. Dry-type rectifiers in series with the load convert the a-c output to the d-c required for generator and motor fields. The use of these regulators in nine different steel processing operations is covered. Among these are tension control for temper-pass mills, control for tandem cold-reduction mills, speed regulation for rod and merchant mills, and control for high-speed slitting and shearing lines. In each case, a flow chart and a schematic diagram are given. Finally, a definitive discussion outlines the physical and electrical characteristics of these new regulators that make them particularly adaptable to heavy-duty service in steel mills. (B-5468). Westinghouse Electric Corp.

(5) Circuit Breaker Manual

A new manual explaining operating principles of basic circuit breaker designs, and providing engineering data on factors of application has just been published. Included in the new manual are simplified diagrams showing the three basic types of circuit breakers in general use today with brief descriptions. Through colored charts and diagrams, explanations of temperature factors, inrush current effects, tripping and reset time, and time delay curves are provided. Also discussed are the questions of quick or slow make-and-break, and wire deterioration rates at various ampere values. While the manual is concerned mainly with branch circuit protection, it should be of informative value to anyone concerned with circuit breaker application. (101). Heinemann Electric Co.

(6) Pump Selector

A new bulletin, "Nagle Pumps Selector" has been published. This illustrated, informative bulletin contains descriptions and suggested applications for nine different widely-used Nagle centrifugal pumps for abusive industrial applications. (952). Nagle Pumps, Inc.

(7) Welding News

Available to you is a big special issue which constitutes the third quarter release of Ampco "Welding News." This particular edition has been increased from the usual four pages in one color to 12 pages and two colors. Generally, it reviews actual application stories of interest to most metal users. Profusely illustrated—52 different actual welding applications using Ampco-Trode and Phos-Trode electrodes are pictured and described. Among the applications shown are overlaid gears and pinions made of cast iron or steel; steel mill maintenance welding; overlaid bearing surfaces and draw dies, fabrication of Ampco Grade 8 sheet and plate for wear and corrosion-resistant services; and the

welding of dissimilar metals. Also featured and described are Ampco Safety Tools and Ampco Weld resistance welding electrodes and accessories. Ampco Metal, Inc.

(8) Electronic Recorders

A catalog is available containing factual information concerning "ElectroniK" non-control precision instruments, which employ a potentiometer, Wheatstone bridge, or other measuring circuit to measure temperature, pressure, flow, pH and a host of other variables. Actually a handbook for engineers' and buyers' use, the literature presents detailed specifications for each particular model. Also included is information on specially adapted "ElectroniK" instruments such as the electrometer, function plotter, scanning system, "TV Dial" recorder, double range precision indicator, and console desk precision indicator. (1520). Minneapolis-Honeywell Regulator Co., Industrial Division.

(9) Unique Service

A booklet is available that describes another unique service that is available from the mechanical division of Arthur D. Little, Inc. This division specializes in blending the scientists' basic knowledge with the engineers' development skills. This provides industry and government with a powerful facility for the development and production of unusual equipment in the fields of thermodynamics, vacuum engineering, gas liquefaction, electromagnetism, mechanical design and vibration. The mechanical division is in the unique position of being able to draw upon mechanical engineers, chemists, physicists, metallurgists, mathematicians, chemical engineers, electronic engineers, biologists and business economists as their special skills are needed. This permits an outstanding combination of talents to solve your specific problems. Such an integration of abilities can rarely be found elsewhere. (MD-1).

(10) Vertical Pump

Construction features of Allis-Chalmers small vertical pumps for sidewall or submerged mounting are described in a new eight-page bulletin just released. Units covered are available in capacities to 250 gpm at heads to 125 ft for coolant circulating, air conditioning, etc. Helpful curves and tables to determine motor frame, horsepower, speed and current characteristics for the various units are included in the bulletin. Also given are construction details of shaft seals and motors. (52B6975A). Allis-Chalmers Manufacturing Co.

(11) Lubrication Data

Just issued is a new bulletin on "Lubrication of Draper-Diehl Power Transmitter Assembly." This technical data, accompanied by a cut-away illustration of the assembly, has been released upon the completion of mill tests which demonstrated conclusively that "Non-Fluid Oil" provides much more positive, cleanly and economical lubrication than ordinary greases. (547). New York & New Jersey Lubricant Co.

(12) Diesel Engine

A new bulletin on the TS Diesel engine has been published recently by Ingersoll-Rand. This 12-page, catalog incorporates sectional wash drawings, installation views, and diagrams to show why the TS Diesel is called a smaller, lighter, but fully heavy-duty engine. It is a 7 in. x 8½ in., 900 to 1000 rpm Diesel in the 200 to 400 hp class. specifications, weights, performance curves, and dimension tables are included in this bulletin. (10027). Ingersoll-Rand Co.

(13) Powder-Cutting Equipment

Literature is available describing a new "Ferrojet" powder dispensing unit for powder-cutting of stainless and other hard-to-cut steels. The new model provides greater uniformity of powder flow as a result of improvements in the powder regulating and ejecting mechanisms. It has been completely redesigned, is simple and more compact than the former model, and costs substantially less. It is also easily portable; the dispenser and a cylinder of the powder-conveying gas can be mounted on an ordinary two-wheel gas cylinder truck. Gas pressure and rate of powder flow are maintained automatically by the dispensing unit. The powder control valve is also automatic, operating simultaneously with the turning on and shutting off of the cutting oxygen valve on the torch. Both machine and hand cutting torches are available for use with the dispenser. For use in foundries a flame washing torch has been developed for the quick removal of riser pads, chill bars, fins, etc. from stainless and other alloy steel castings. The torch is said to be up to ten times faster than chipping and grinding. (N-150). National Cylinder Gas Co.

(14) Tungsten Carbide

Metal Carbides Corp. announces the publication of a new 72-page general catalog which covers their full line of tungsten carbide products, including cutting tools, draw dies, bushings, gages, centerless blades, rolling mill work rolls, diamond wheels and wheel dressers, and solid carbide stock. Extensive engineering data is included on speeds and feeds, brazing and grinding instructions, grinding wheel recommendations, coolants, etc. A considerable number of new products have been added to the "Talide" line of cemented carbides with standard package quantity discounts extended to include many items not heretofore covered. (52-G). Metal Carbides Corp.

(15) Safety Marking Tools

Over one hundred different marking tools and devices are described and illustrated in a new 28-page safety marking tool catalog just published. This brochure includes photographs of the various products; descriptive material; catalog numbers; and in cases where the information applies, charts of the various sizes. In addition to the products themselves, the catalog includes information on "Mecco" safety steel, a specially-developed alloy which is said to reduce spalling and mushrooming, and increase marking life. Almost all products in this line are made of safety steel; the few which are not, such as "Luminum-Line" holders, are made from special alloy aluminum to resist damage from impact. The basic groupings of products in this catalog are as follows: stamps made to order hand stamps, inspection and symbol stamps, letter and figure stamps, mold stamps and press stamps; marking machines and fixtures; special marking outfits; press and hand type holders; dies and die inserts; engineers and inspection hammers; and steel type. (100). M. E. Cunningham Co.

(16) Hook-On Instruments

A new booklet describing General Electric's complete line of hook-on instruments has been announced as available. The bulletin contains applications, operation, and basic features of the G-E hook-on type AK-1A volt-ammeter; AK-2 wattmeter; and AK-3 power factor meter. (GEC-901). General Electric Co.

(17) Babbitting Practice

A new booklet published by

Federated Metals Division, American Smelting and Refining Co. outlines basic steps for the prevention of common bearing failures. "Hints On Babbitting Practice" covers everything from the choice of metal for a particular bearing application through the correct pouring practice to in-service maintenance. (146). Federated Metals Division, American Smelting and Refining Co.

(18) Volt-Ammeter

A new descriptive folder on the Type AC-1 Columbia volt-ammeter is available. This volt-ammeter, a new instrument, recently announced to the trade, is a clamp-type, hand size instrument for use on alternating current, that measures up to 600 amperes and 600 volts. It is equipped with ranges of 0-12, 0-60, 0-120 and 0-600 amperes, 0-150 and 0-600 volts. The instrument is easily held and operated with one hand, weighing less than two pounds. Price is $75.00, complete with voltage leads and carrying case. Columbia Electric Mfg. Co.

(19) Motor-generator Sets

Engineered motor-generator sets for all industries form the subject of a new, 4-page, illustrated bulletin just issued. Briefly described is a complete line of "custom-tailored" m-g sets— shunt or compound wound, from ¾ to 1000-kw—built to provide power for constant-voltage or adjustable-voltage systems and engineered to include synchronous or induction motors. Also included are six typical applications of these m-g sets showing their utilization for large single-motor drives, excitation of synchronous machinery, multi-motor drives, and "spot conversion," an economical means of supplying d-c power at the point of use. (F-2502). Reliance Electric & Engineering Co.

(20) Centralized Lubrication

A new 4-page illustrated folder has been published. Pertinent points about the application of this patented automatic lubrication systems are covered. Includes engineering description of technical methods of operation, in the case of both Trabon's reversible and manifold types of lubrication systems. This general bulletin will be useful for anyone interested in the proper planning and engineering of centralized lubrication. Applicable to a tremendous range of large and small machinery. (529). Trabon Engineering Corp.

(21) Wire Rope Handbook

A fact-packed, 64-page "Wire Rope Handbook," that helps users become more expert wire rope buyers, is available. It contains valuable, every-day information in handy size booklet that fits conveniently in a jacket pocket, or neatly on a shelf or in a desk drawer. The contents include descriptions, diagrams and illustrations of wire rope types and constructions, as well as helpful information about lubricants, working loads, safety factors, and specifications. Forty separate charts give breaking strengths and weights of wire rope by constructions and sizes, along with calculations for the proper selection of wire rope attachments. (R-51). A. Leschen & Sons Rope Co.

(22) Rotary Pipe Straighteners

Production experience records on straightening pipe and tubing in seven different plants are compiled in a technical bulletin which has been published. The new 8-page booklet presents in "case study" form a variety of ways in which selected models of the company's rotary straighteners have helped solve plant production problems. Typical of the data presented in this bulletin are straightening problems on from ⅛ in. nonferrous tubing to 4 in. steel pipe. The new literature covers such subjects as quantities of tubing straightened per shift; increases gained in tube production; straightness specifications met; types and lengths of materials straightened, plus data on diameters, wall thicknesses and tensile strengths of pipe and tube produced in the seven selected plants using these machines. (52). Mackintosh-Hemphill Co.

(23) Ball Transfers

Publication is announced of a four-page folder giving general and specific data on the construction and use of ball transfers. These transfers move materials horizontally in any direction; manipulate plates around shears and punches; and move materials on or off scale platforms. Inside pages give technical data and drawings showing construction of six different types of these popular units. The back page lists other products of the Mathews Conveyer Co.

(24) Selenium Rectifier Welders

A 4-page folder provides details on a new Miller selenium rectifier d-c type welder. Explains in detail this new development that opens up entire new fields in welding applications, with specifications on the four models to meet various requirements. Miller Electric Manufacturing Co.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

DECEMBER, 1952

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	50	51	52	53	54	55	56	57	58	59		
60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75		
76	77	78	79	80	81	82	83	84	85	86	87						

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER

1011 EMPIRE BUILDING

PITTSBURGH 22, PA.

PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADAMS CO., INC., R. P.	BULLETIN 691	Puro-Stone filters.
51	ALLIS-CHALMERS MANUFACTURING CO.	BULLETINS 05B6032A AND 05B6002A	Heavy duty steel mill.
52	ALLIS-CHALMERS MANUFACTURING CO.	BULLETIN 14B6505A	Type 260 DC contactor.
53	AMERICAN BRAKEBLOK DIVISION, AMERICAN BRAKE SHOE CO.		A-B-K bearings.
54	AMERICAN CHEMICAL PAINT CO.		Folder on "Rodine."
55	ASKANIA REGULATOR CO.	BULLETIN 141	Askania edge position control.
56	BLISS CO., E. W.		Bliss mills and accessories.
57	BRISTOL CO.		Bristol thermocouple and pyrometer accessories.
58	BRISTOL CO.		Dynamaster performance.
59	CRANE CO.	FOLDER AD 1667	Crane valves.
60	CLEVELAND WORM AND GEAR CO.	CATALOG 400	Cleveland drives.
61	CUNNINGHAM CO., M. E.	CATALOG 100	Production marking.
62	DIAMOND POWER SPECIALTY CO.	BULLETIN 1025E	Diamond "Utiliscope."
63	DOWELL, INC.		Chemical cleaning for steel mill equipment.
64	ELECTRIC SERVICE MANUFACTURING CO.		Keystone integrated aluminum conductor system.
65	ELLIOTT CO.	BULLETIN P-B-5000	Elliott motor design.
66	FARREL-BIRMINGHAM CO., INC.		Bulletins on Farrel roll grinders.
67	FOOTE BROS. GEAR AND MACHINE CORP.	BULLETIN GMA	Gearmotors.
68	GULF OIL CORP.		Gulf periodic consultation service.
69	HARNISCHFEGER CORP.	BULLETIN C-42	P&H mill type cranes.
70	HYATT BEARINGS DIVISION, GENERAL MOTORS CORP.	CATALOG 150	Hyatt bearings.
71	INDUSTRIAL GEAR MFG. CO.		"A Trip Through Industrial."
72	JOHNS-MANVILLE	BROCHURE IN-134A	Superex block insulation.
73	KAISER ALUMINUM & CHEMICAL SALES, INC.		Permanente 165 and Permanente 84.
74	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Fast's couplings.
75	LUBRIPLATE DIVISION, FISKE BROTHERS REFINING CO.	DATA BOOK NO. 1-52.	Lubriplate lubricants.
76	MATHEWS CONVEYOR CO.	CATALOG 852	Continuous flow conveying.
77	MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL DIVISION	CATALOG 7000	Pressure and vacuum gages.
78	NATIONAL CARBON CO.	BULLETIN CP-2426	"National" standardized brushes.
79	OAKITE PRODUCTS, INC.		Metal cleaning.
80	PITTSBURGH LECTROMELT FURNACE CORP.	BULLETIN 7	Lectromelt furnaces.
81	POOLE FOUNDRY AND MACHINE CO.		Flexible couplings.
82	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN F-2051	Floating worm gearmotors.
83	SURFACE COMBUSTION CORP.	BULLETIN SC-155	Controlled atmosphere furnaces and generators.
84	UNITED STATES GRAPHITE CO.		USG brushes.
85	WAGNER ELECTRIC CORP.	BULLETIN MU-131	Steel-frame motors.
86	WALDRON CORP., JOHN		Gear type couplings.
87	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-5420	D-C constant voltage crane hoist control.

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

DECEMBER, 1952

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	50	51	52	53	54	55	56	57	58	59		
60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75		
76	77	78	79	80	81	82	83	84	85	86	87						

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 34.9, P. L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1011 EMPIRE BUILDING
PITTSBURGH 22, PA.

NAME _____ TITLE _____

DEPARTMENT _____

COMPANY _____

CO. ADDRESS _____

CITY _____ ZONE _____ STATE _____

Splitting Hairs.. IN STEEL

with ASKANIA Edge Position Control

A Pittsburgh district steel mill slits this ¼" rough edge from 15-ton reels of blackplate at 3,000 feet per minute with accuracy of ± 1/64". They do this precision edge-positioning job with Askania Hydraulic Edge Position Control.

Askania Edge Position Control is a new use for the Askania Jet Pipe Regulator, long the educated muscle of the steel mill. Steel men asked for it, because they needed the dependability and simplicity of Askania in this control job.

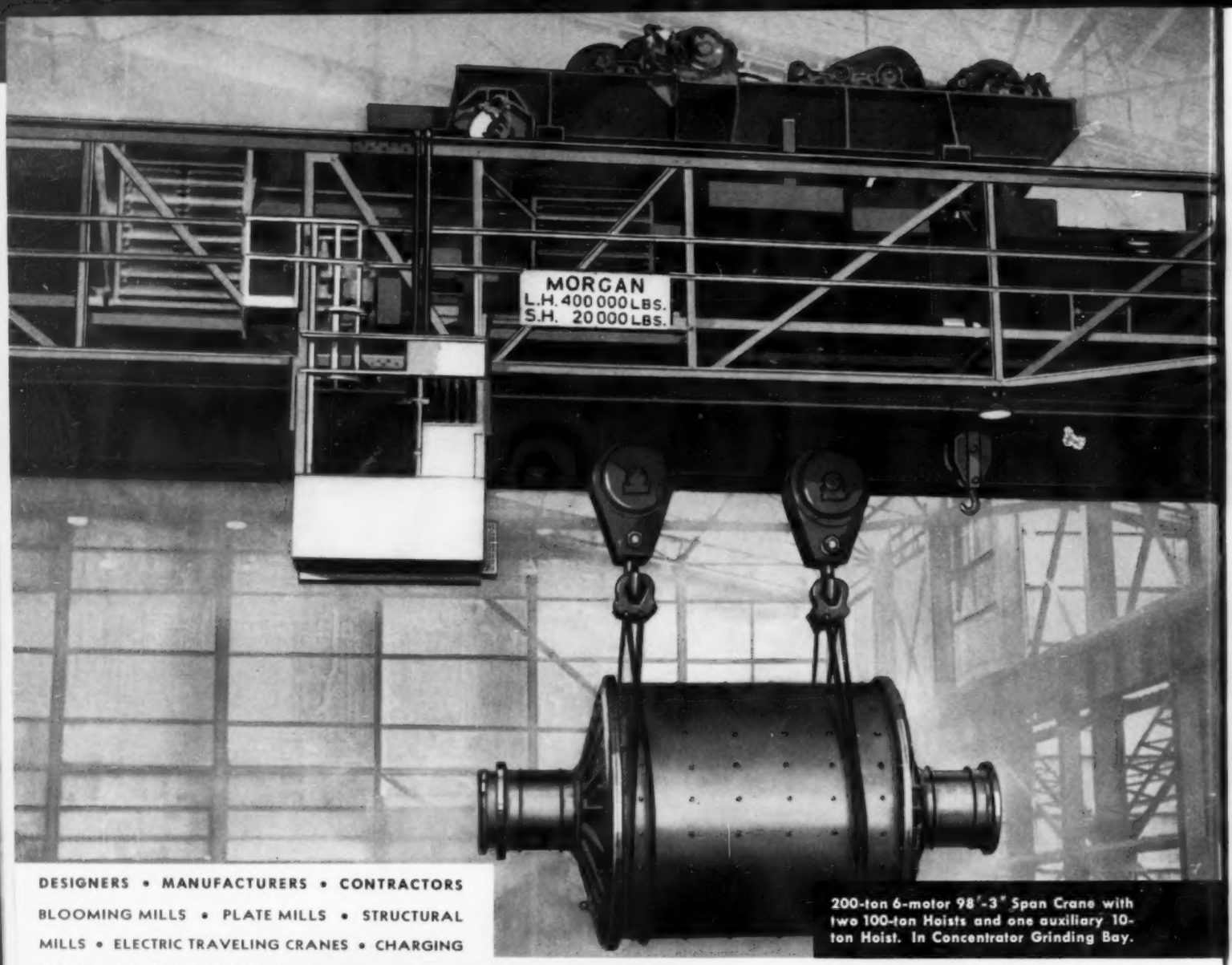
Nothing touches the steel but a stream of low pressure air. Available force is practically unlimited. The equipment is low in cost. There is nothing delicate about it. It's built to take all the abuse that continuous operation in hard service can give it.

Find out now about Askania Edge Position Control. See your Askania Representative, or write for Bulletin 141.

ASKANIA REGULATOR COMPANY

240 E. ONTARIO STREET • CHICAGO 11, ILLINOIS

A Subsidiary of General Precision Equipment Corporation



200-ton 6-motor 98'-3" Span Crane with two 100-ton Hoists and one auxiliary 10-ton Hoist. In Concentrator Grinding Bay.

DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

BUILT BY MORGAN Engineering

MORGAN CRANES AT "CHUQUI"

Illustrated are three Morgan Heavy Duty Mill Type Cranes at Chile Exploration Company's new plant at Chuquicamata. These cranes are of very rugged construction, especially designed for copper smelter service. *Your inquiries will be appreciated.*

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO PITTSBURGH—1420 OLIVER BUILDING

100-ton 6-motor 70'-0" Span Crane with two 25-ton Auxiliary Hoists. In West Converter Aisle.

100-ton 6-motor 70'-0" Span Crane with two 25-ton Auxiliary Hoists. In East Converter Aisle.

Equipment News...

NEW TINNING LINE

▲ A new high-speed vertical-acid type electrolytic tinning line, capable of tinning enough steel every second to make 50 average-size tin cans, has begun operation at the Fontana, Calif. plant of the Kaiser Steel Corp.

Rated at 1200 fpm, the new line will produce more than 10 two-foot long sheets of tinned steel per second. The entire process is automatic, including the uncoiling, cleaning, pickling, plating, reflowing, oiling, shearing, classifying, and piling of the tin-coated steel strip.

General Electric Co., working closely with Kaiser engineers, supplied the complete electrical system for the installation. G.E. furnished a photoelectric loop control for the strip-propelling phase of the operation and controls for the electrolytic cleaning, pickling, plating, reflowing, and chemical-treatment processes.

Two giant control panels, each over 90 feet long, are used to regulate the a-c and d-c sections of the tinning line. High and low voltage distribution switchgear are incorporated in the control panels.

Two 1500-kva transformers furnish the power for the flow-brightening equipment. A 60,000-volt power pack supplies the electro-static charge for oiling the strip after it has been tinned. Other G-E equipment includes motors, motor-generator sets, transformers, and instrumentation.

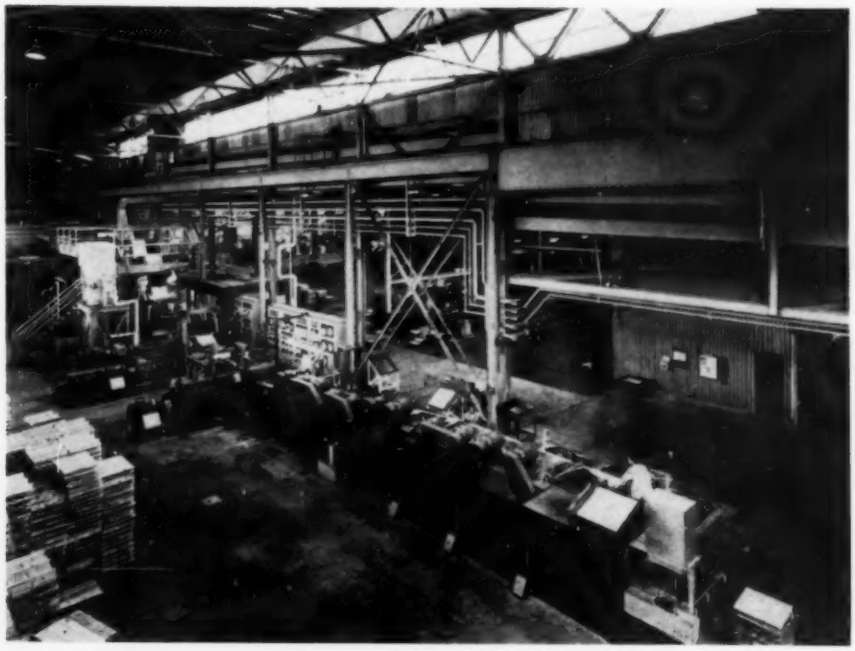
The new Kaiser installation employs a G-E beta-ray gage in its first application on a continuous tinning line. This non-contacting gage continuously and automatically monitors the thickness of the tin plate as it passes through the line. A G-E pinhole detector checks the strip for pinholes and other imperfections.

General Electric engineers introduced a new improvement on the sheet classifier whereby different flights of the classifier can be shut down and jogged to clear up a cobble; then reaccelerated without shutting down the line. This feature greatly reduces the amount of plate formerly damaged when the line had to be stopped, the engineers said.

The Kaiser tin plate mill is equipped to commercially produce differential coating of tin plate.

The starting of the line marks the completion of Kaiser's over-all project to furnish tin plate for the ever-increasing demands of the booming West Coast canning industries.

Kaiser Steel's new vertical-acid type electrolytic tinning line is shown here from the drive side of the delivery end. Installed at the Fontana, Calif. plant, the line marks the completion of an expansion program to meet the demand of West Coast canning industries.



INSULATION FIREBRICK

▲ An insulating firebrick that increases furnace efficiency and helps reduce operating costs has been introduced by the Zonolite Co. The brick, made of vermiculite and clay binders, has extremely low thermal conductivity, which prevents excess heat loss in constant or intermittent furnace operations, with a resulting saving in fuel costs.

Vermiculite, the micaceous mineral produced by Zonolite, is the key ingredient and provides the efficient insulating quality of the brick.

Extensive testing by Zonolite shows that the bricks have high resistance to cracking caused by impact or thermal shock, have good physical and chemical stability within their temperature range, and are easily sawed and fitted without breakage.

The brick is designed primarily as back-up insulation for refractory brick in the service range up to 1800 F. When not subjected to mechanical abrasion, or exposed to molten slag or metal, however, it can be used as facing brick when temperatures are not higher than 1800 F.

The bricks are made in standard nine inch series, and are packed in cartons of 25 each. Any good refractory mortar can be used with them.

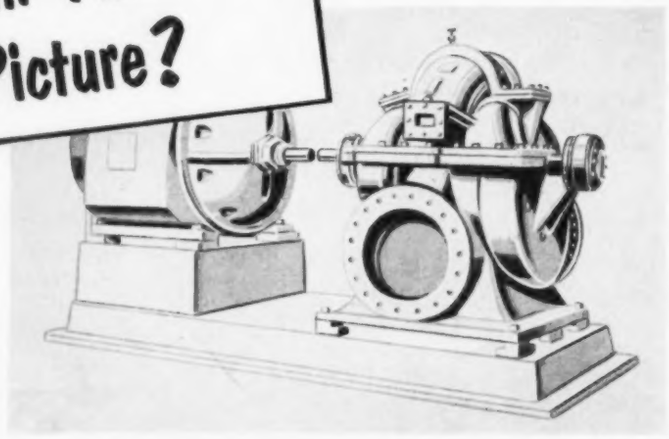
The insulating firebricks are produced at the Zonolite company's plant at Travelers' Rest, S. C., and are obtainable nationally through Zonolite plants, licensee plants and brick distributors.

The physical properties of the new firebrick are the following: Maximum service temperature 1800 F; density in pounds per cu ft 35; weight per brick 2.1 lb; thermal conductivity 1.25 at 700 F mean; cold crushing strength in psi 185; modulus of rupture in psi 145; per cent of linear shrinkage after reheating to 1600 F 0.1; and per cent of linear shrinkage after reheating to 1800 F 2.0.

DIESEL-ELECTRIC UNITS

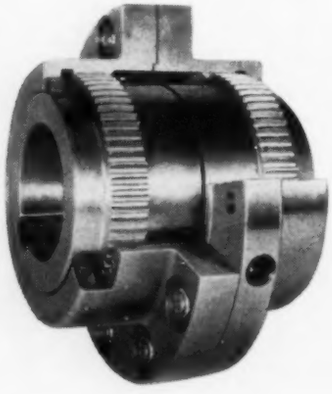
▲ Continuous-duty diesel-electric power is now available for electric industrial trucks in the popular 4000 lb fork and up to 10,000 lb platform sizes. Ready-Power Co., veteran manufacturer of gas-electric power

What's Missing In This Picture?



It is the one thing that will make these two pieces of equipment operate properly—a SHAFT COUPLING. Any shaft coupling will permit the motor to drive the pump. But the frequency of shutdown for repairs and the extent of damage to costly equipment depends entirely on the design, construction and quality of the coupling installed. To insure longer trouble-free operation, more and more buyers specify the

WALDRON *Improved* GEAR TYPE Couplings

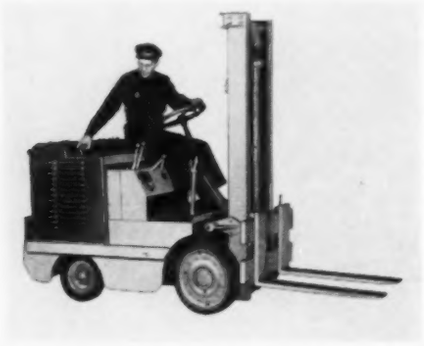


Their noteworthy design and operating features naturally appeal to men who understand transmission problems and requirements. All steel construction for maximum ruggedness; one piece cover sleeves; accurately crowned gear teeth; longer lining up surface; absence of all adverse crank action on shaft and bearing—these and other features combine to eliminate the usual causes for coupling failure.

Available in all types and sizes—design easily adapted for special applications. Write today for descriptive catalog and specific engineering data.

JOHN WALDRON CORPORATION
NEW BRUNSWICK, NEW JERSEY
Sales Representatives In Principal Cities

units, announced its new model "N" as the latest in the company's growing line of diesel-electric models. Previous diesel-electric models have proved to be highly successful on larger electric industrial trucks.



Complete with fuel tank and starting battery, these new diesel-electric units provide low-cost operation and longer service for industrial lift trucks.

To truck operators these diesel-electric power units offer the same advantages that diesel-electric locomotives provide to major railroads: the lowest known operating costs, greatly reduced maintenance, and much longer life expectancy.

Ready-Power model "N" is designed to fit sit-down type fork trucks without need for alterations. The unit is complete with fuel tank and starting battery. These units are available on new trucks through electric truck manufacturers.

CONTINUOUS CASTING

▲ First commercial installation of a new type machine that converts molten steel into solidified billets or slabs in a continuous line will be started at Welland, Ontario, Canada within a few months.

Koppers Co., Inc. and Atlas Steels, Ltd., of Welland today announced details of a contract by which Koppers will design and construct a continuous ferrous-metals casting machine to produce tool, stainless and other high grade steels. This revolutionary development will yield from 10 to 15 per cent more finished steel per heat than conventional pouring methods.

With an uninterrupted supply of molten metal, the new machine would be capable of casting a continuous billet or slab of indefinite length. In actual practice, automatically-moving acetylene torches will cut the metal into usable lengths as it emerges from the casting machine.

THERMIT WELDING
Speeds PUNCH to Steam Hammer

Serious losses in production threatened a large mid-western forging company, due to long delays in obtaining forgings the size of a complete 35,000 lb. ram. It was, therefore, decided to manufacture the ram for a steam hammer by joining two smaller forgings with Thermit Welding (Fig. 1) . . . a job which took only two weeks. The fabricated ram has seen many months of severe service (Fig. 2), and based on its excellent record, others are being built in the same way.

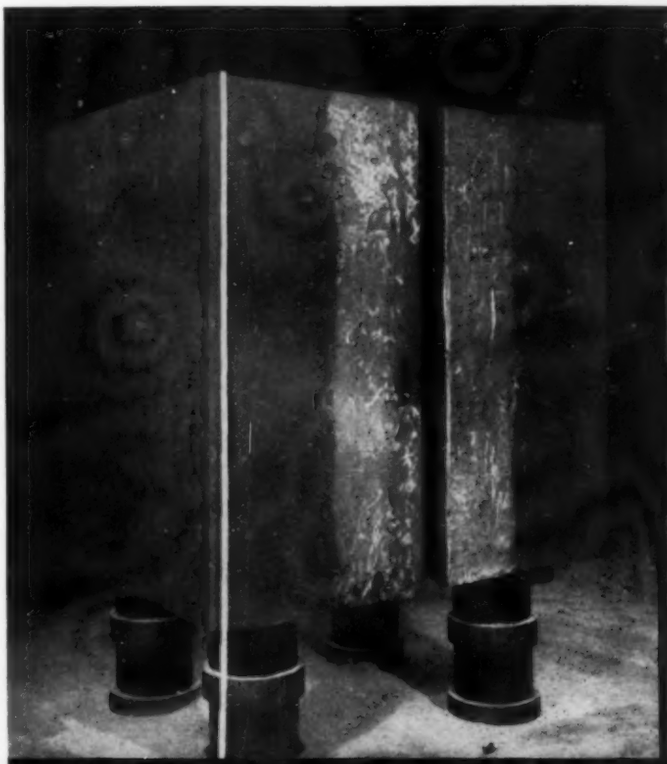


Fig. 1—Two forgings for ram in position prior to Thermit Welding.

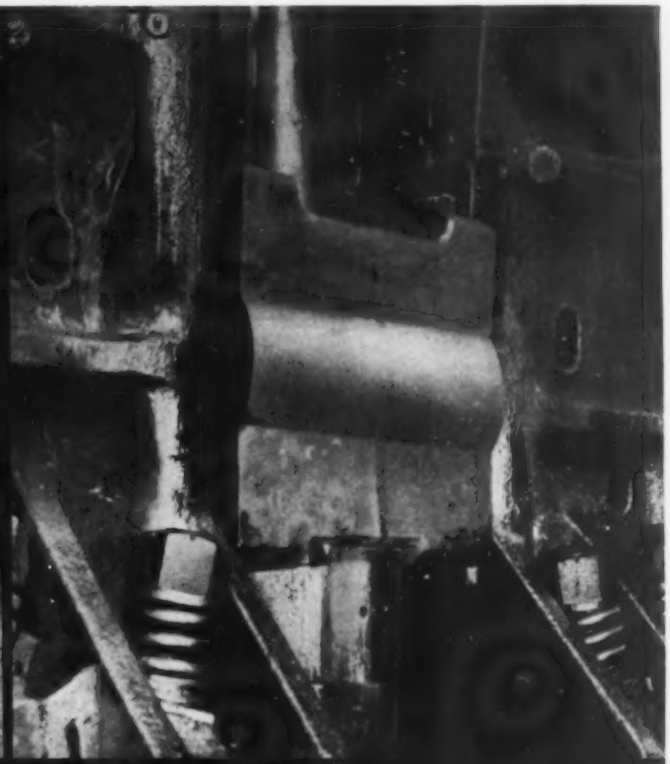


Fig. 2—Finished 35,000 lb. ram after fabrication by Thermit method.

CONSISTENTLY SOUND WELDS . . . MINIMUM OF TECHNICAL SKILL NEEDED . . . SPEEDY REPAIRS . . . LOWER THAN REPLACEMENT COSTS—four hard-hitting reasons for the swing to Thermit Welding in the repair, manufacture and maintenance of heavy drop forge industry equipment. Contact M&T on how Thermit Welding can help you!

THERMIT WELDING

METAL & THERMIT CORPORATION

100 EAST 42nd STREET • *NEW YORK 17, N. Y.*

NEWARK, N. J. • PITTSBURGH, PA. • E. CHICAGO, IND.
SO. SAN FRANCISCO, CAL. • PHILADELPHIA, PA. • TORONTO, CANADA

Continuous casting machines have long been a dream of the steel industry, since in certain specific applications, particularly in small and medium-sized plants, such machines will allow by-passing of the blooming mill and soaking pits in the steel-making operation with sizable cost-savings.

These continuous casting machines have been used in the nonferrous industries for several years in this country and abroad. Junghans machines, upon which the original patents were based, are operating on steel and other metals in Germany. In 1949 a pilot machine for steel was erected at the Allegheny Ludlum Steel Corp. plant at Watervliet, N. Y. to resolve further the problems presented in continuous casting of steel. Allegheny's exhaustive research was joined by the Freyn Engineering Department of the Engineering and Construction Division of Koppers over a year ago when Koppers purchased the right from Continuous Metalcast Co., Inc., to design and build such machines under the Rossi-Junghans Patents. The Atlas installation will be the first embodying the new developments which have been thoroughly tested in pilot operation.

Koppers engineers now are convinced that the machine can be successfully adapted to cast all ferrous-metal types, including mild steels, although greatest savings to steel companies will accrue in continuous casting of specialty steels.

Operation of the continuous casting machine starts, of course, with adequate facilities for melting. From these facilities, the molten metal is transferred to the machine and poured into a refractory-lined vessel. This vessel or tundish has a nozzle at the bottom which directs the metal into a copper mold.

The walls of the copper mold contain drilled passages through which water is circulated in order to extract the heat from the solidifying metal. An essential part of the process is the mold oscillation in which the mold moves downward with the casting for a certain distance and then returns quickly. This action keeps the metal from sticking to the mold as it hardens and increases the mold efficiently.

In order to start the casting operation, a dummy billet or slab of nearly the same cross section as the casting is inserted halfway into the mold from the bottom. The end of the dummy in the mold is packed to prevent molten metal leaking down the sides as the first metal is poured into the mold. When the mold is nearly filled, the machine is started, the pinch rolls draw down the dummy with the new formed casting attached and continuous casting is underway.

As the casting emerges from the bottom of the mold, it passes through water sprays which complete solidification and through withdrawing rolls which control the speed of casting. Below these rolls is the acetylene torch which automatically cuts the casting to desired length.

From the cutting torch, pieces are received by a mechanical device which delivers them from the pit beneath the machine to a conveyor above ground. The discharged pieces are now ready for conditioning if necessary, reheating and rolling to finished sizes.

OVERTRAVEL ON SCREWDOWNS SOLVED!
USE Stearns MAGNETIC BRAKES
TO PREVENT UNDUE DRIFT OF YOUR SCREW DOWN MECHANISM
LOEWY

Here's an installation of a 4-High High Speed Rolling Mill for Strip and Foil built by Loewy Rolling Mill Division, Hydropress, Inc., properly equipped with STEARNS Magnetic Disc Brakes.

Quickly stopping the adjusting screws on this Loewy High Speed Rolling Mill is everyday work for STEARNS Magnetic Disc Brakes. Designed with a quick, steady pressure that brings a fast stop in the shortest time, STEARNS Magnetic Disc Brakes prevent overtravel of the adjusting screws and thus allow for careful, positive adjustment. Suitable for horizontal or vertical applications, STEARNS brakes are available in sizes up to torques of 575 pounds feet.

What is your overtravel problem? Give us the details; we'll forward recommendations without obligation. Remember, there's a STEARNS EXPERIENCE ENGINEERED unit for your screwdown requirements.

Foremost in the Magnetic Field

Stearns MAGNETIC INC.

681 South 28th Street • Milwaukee 46, Wisconsin

Koppers will build the continuous casting machine for Atlas Steels at its Metal Products Division in Baltimore, Md. This machine will produce 4-¼ by 4-¼ in. billets; 5-½ by 7-½ in. billets; and 5-½ by 21-½ in. slabs.

With different molds, the machine also could produce rounds. The Atlas Steels machine is capable of casting at speeds from zero to 100 in. per minute. Metal flow is regulated by increasing or decreasing the level of the molten metal in the tundish above the mold.

Height of the machine will differ in various installations depending on the cross section cast and length of pieces cut. In the Atlas installation, the height from plant level to machine operating floor is 30 ft.

Joseph Becker, vice president and general manager of Koppers' Engineering and Construction Division, said that development work on the machines will be pursued continuously to further develop techniques and broader uses.

"Koppers does not believe, however, that these machines will outmode blooming mills and soaking pits throughout the steel industry," Mr. Becker said. "In many large operations with ordinary steels, smaller savings could be effected through use of continuous casting. For making higher priced steels and in some cases such as where present blooming mill capacity is not up to melt furnace capacity, the machines will provide substantial savings, which will become even greater as more practice results in improved techniques."

SURFACE GRINDER

▲ A surface grinder called the Curtin-Herbert "Micro-Grinder," is being manufactured that will face wide web sheets of leather, plastic, felt, cork, rubber or metal, maintaining a thickness tolerance of ±0.0005 in. on the finished stock. Developed by Curtin-Herbert Co. of Gloversville, N. Y., in co-operation with Behr-Manning Corp. of Troy, N. Y., the machine produces this degree of accuracy through the use of a coated abrasive cover, spiral wound on a cast iron back-up roll. Machine widths range from 12 to 80 in. but widths of 40 to 52 in. are standard.

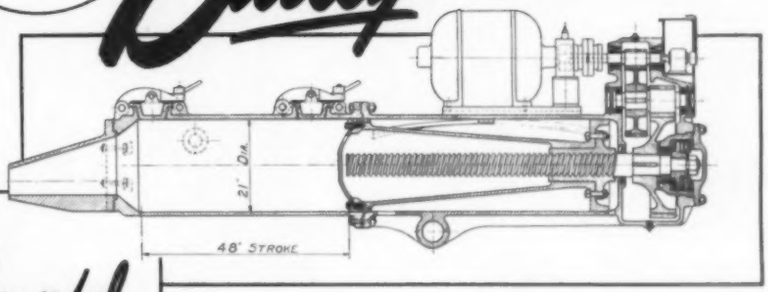
Accuracy of the finish-ground web depends on the hardness of the material to be ground and the amount of the stock to be removed. On relatively soft non-metallics, 0.0625 ±0.0005 in. of stock can be removed in one pass through the grinder. Extremely hard non-metallics, such as mica and laminated phenolic, have been given a 0.030 ±0.0005 cut at one pass.

The coated abrasive cover is spirally wound around a centrifugally-cast normalized cast iron drum that is machined to a tolerance of ±0.0005 in. The edges of the coated abrasive cover do not overlap but are butted together. This mounting technique

Rubber-covered pinch rolls feed the web stock into the grinding area. A steel billy roll, adjusted by handwheels, supports the stock as it is ground.

Long and Uniform Tapping Holes

Bailey CLAY GUN



Powerful

A powerful electrically-driven piston assures unfailing performance.

Best results and safety in plugging blast furnace tapping holes are obtained with the Bailey Clay Gun. The special Bailey Lever Action forces the nose of the gun forward with positive accuracy. A powerful, motor-driven screw provides the piston pressure necessary to maintain long tapping holes.

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA.

for the drum cover permits utilization of the entire drum periphery.

The cover is secured by a series of clamps that fasten to movable heads on each drum end. These movable heads exert tension on the coated abrasive drum cover outwardly and in the direction of the spiral.

Either an oscillating or non-oscillating type drum can be used on the grinder. However, a more uniform finish is generated by the oscillating drum and the life of the coated abrasive is longer than on the non-oscillating drum. The grinding drum is completely enclosed and an exhaust duct built into the hood removes the swarf generated by grinding.

The web stock to be ground is fed into the grinding area by a series of rubber-covered pinch rolls. Mounted directly under the grinding roll is a precision ground steel billy roll that supports the stock as it is being ground.

This billy roll is accurately adjusted vertically by two handwheels positioned on the operator's side of the machine. Either handwheel will actuate the worms and gears that move the billy roll up to the grinding drum. Moving either handwheel a full revolution will raise or lower the billy roll 0.005 in. A powered elevating mechanism with limit switches can be installed as optional equipment. A dial indicator, graduated in thousandths of an inch, is set on the feed table to provide a visual means of adjusting the cut.

For making adjustments that are finer than can be made with the dial indicator, graduated collars on the handwheels are marked in increments of 0.0001 in.

The billy roll is ground in the machine in order that it will be round and parallel to the grinding drum.

The sueding machine, a version of the "Micro-Grinder," has found wide application in the textile industry.

This machine is equipped with wind and un-wind rolls to suede continuous webs of artificial and natural fiber textiles. A "nap" is raised on the cloth and surface imperfections such as "motes," "Neps" and "slubs" are removed. Textile processors for the glove trade have been the largest purchasers of these machines.

ELECTRONIC TRUCK SCALE

▲ New modern electronic type scales for weighing motor trucks and railroad cars are now in production at Cox and Stevens Aircraft Corp. These

new units are an outgrowth of 10 years' experience by this company in the electronic weighing of aircraft. The manufacturer claims many ad-

WHAT'S THE FASTEST WAY TO CLEAN METAL?
See page 11
WHAT'S THE MOST ECONOMICAL WAY?
See page 9
Some good things to know about Metal Cleaning

Oakite's FREE Booklet

"Some good things to know about Metal Cleaning"

answers many questions that mean better production, more profit for you. Just look at the table of contents:

- Tank cleaning methods
- Machine cleaning methods
- Electrocleaning steel
- Electrocleaning nonferrous metals
- Pickling, deoxidizing, bright dipping
- Pre-paint treatment in machines, in tanks and by hand
- Paint-stripp·ng
- Steam-detergent cleaning
- Barrel cleaning
- Burnishing
- Better cleaning in hard-water areas
- Treating water in paint spray booths
- Rust prevention
- Machining and grinding

FREE For this 44-page illustrated booklet, write Oakite Products, Inc., 19 Rector St., New York 6, N. Y.

Technical Service Representatives in Principal Cities of U. S. & Canada

OAKITE SPECIALIZED INDUSTRIAL CLEANING MATERIALS • METHODS • SERVICE

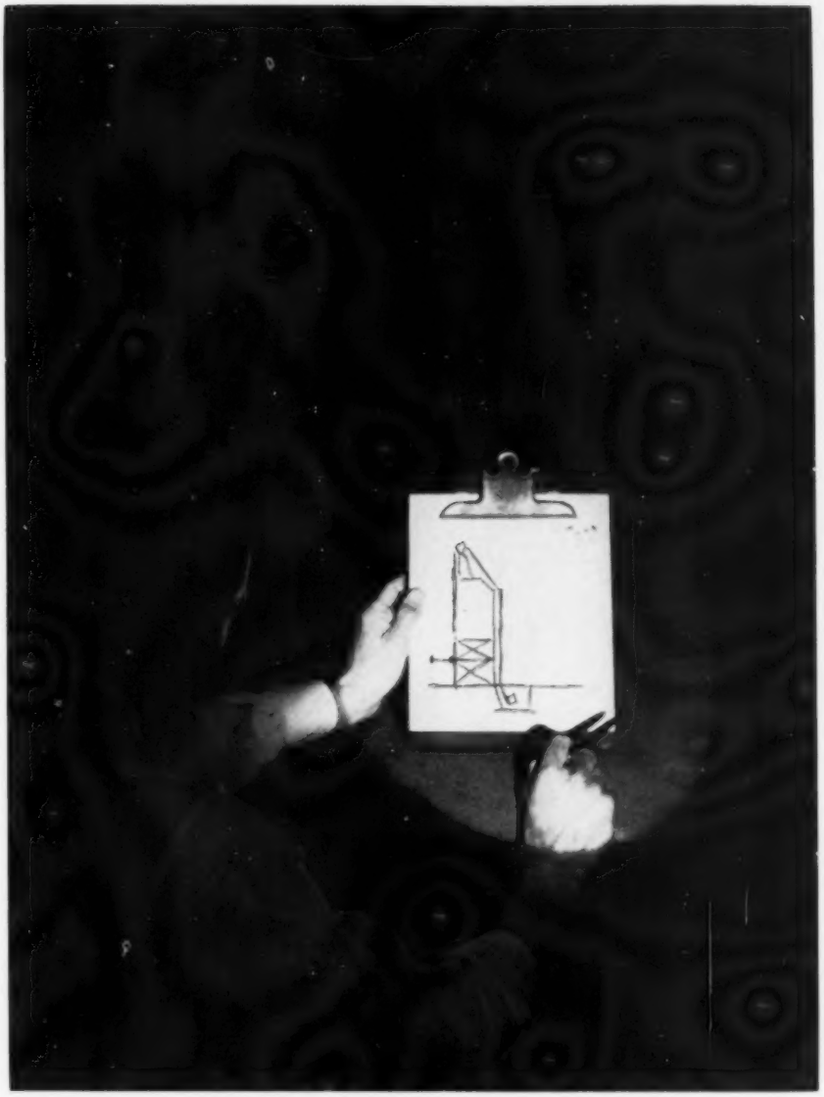
Mecco **SAFETY** ROUND SHANK TYPE HOLDER

With the knurled shank designed to permit a firm, positive grip, the Model RS Type Holder is made of Mecco Safety Steel to eliminate mushrooming and spalling. The type is interchangeable, and the holder can be made for either one or two lines of type. Includes patented snap slide for quick changing of type.

Write for Catalog 100.

M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS

1041 Chateau Street • Pittsburgh 33, Pa.



HOW TO STOP "BURNING THE MIDNIGHT OIL"

R&S engineers can convert your rough sketches of bulk material handling problems into finished engineering drawings, convert drawings into fabricated units, and then follow through on erection if desired . . . the whole job or any part of it . . . any time you are ready.

More than 50 years of engineering, fabricating and construction experience: this is the invaluable extra you get when you stop "burning the midnight oil" and send your rough ideas to Roberts and Schaefer Company for development.

What's **your** bulk material handling, processing, storage or service problem?

ROBERTS and SCHAEFER CO.

ENGINEERS AND CONTRACTORS

130 North Wells Street, Chicago 6, Ill.

HIBBING, MINN. (Box 675)

HUNTINGTON, W. VA

NEW YORK 19, N. Y.

PITTTSBURGH 22, PA.

vantages for the new equipment. Priced lower than most lever system scales, additional savings up to $2,700 may be realized per installation due to the shallowness of the pit required.

Truck platforms are supported by four or six electronic weighing cells depending upon capacity. These cells are but 6 in. high, are hermetically sealed, and contain permanent resistance wire strain gage units which transmit the weight impulse to the indicator. No other equipment is required in the scale pit. Track scales normally require eight such weighing cells of a larger individual capacity.

Truck scale capacities range from 10 tons to 50 tons. Track scales go as high as 400 tons. All standard platform and weighbridge sizes are available in each category.

Unlike lever systems the installation of electronic scale equipment does not represent a major investment. For this reason a further advantage lies in the practicality of relocating the scale should the original location ever become obsolete. For check weighing and modernization the electronic equipment may be installed in most existing track lever type scales.

Both visual and printed weights are offered in the MP-1 model. Standard tolerances are guaranteed and weights in the 100,000 lb range may be printed and read in 5 lb increments. On 200 ton track scale equipment weights may be printed to the nearest 50 lb.

DUSTLESS SAW

▲ Safer, dust-free sawing of refractory and masonry materials is now possible with an "Eveready Briksaw." Perfectly fitting shapes for the relining of furnaces, boilers, kilns, and acid chambers can be made quickly and easily—without dust!

This dustless (wet cutting) saw virtually eliminates the "dust problem." Any number of intricate cuts—angles, bevels, outlet cuts, feather edges—and special shapes—skews, splits, soaps, etc. can be made right alongside the bricklayers or furnace builders. No longer is it necessary to carry the sawed material long distances from the saw to the job. The dustless saw can be used inside in confined areas—even next to intricate machinery, interior furnishings, or equipment. With this saw, dustless

Capable of making any number of intricate cuts, this wet-cutting saw makes possible the dust-free sawing of refractory and masonry materials. A high capacity centrifugal water pump washes dust and particles away in a steady spray of water, leaving the work area clean.

cutting is made possible by a high capacity centrifugal water pump. All dust and material particles are swept away in a constant water spray, leaving the entire work area completely dust-free.

An additional safety measure of this saw is the "Snap-Lock" hinged blade guard that not only serves as a protective shield, but protects the operator from any discomfort from water spray.

SAFETY MEASURES

▲ General Blasting Corp. has made announcement of two important steps taken, to insure complete safety, in their blasting operations.

First, is the use of two-way radio, which will be a must on every blasting job. Five of these modern communication units will be used on each job, with four of them strategically manned at the safe boundary limits, and at road or rail crossings, and the fifth used as the key broadcast unit, manned right at the blasting point. Signals will be broadcast for the "alert" to all outlying positions, and the "all clear" at the completion of each charge, with constant contact being maintained with all four stations, from the key station, preceding, during and following each operation.

Second, is the use of "Polaroid" cameras to photograph, and instantly develop, pictures of all areas surrounding the blasting point before, during and after each blast job. Aerial photography will also be used extensively. These photographs will be used by engineers, to study terrain, proximity, danger points, and building construction.

SNOW PLOW UNIT

▲ The arrival of winter and the certainty of snow—and more snow, should remind fork-truck users that a snow plow attachment is now available, according to the Clark Equipment Co. The snow plow is designed for use on all Clark pneumatic-tired fork trucks excepting the 1000-lb "Trucloader."

The plow is a non-hydraulic attachment which is adjusted manually to several blade angles, and which is mechanically adaptable to uneven ground surfaces. The ballast box, mounted directly over truck forks, may be loaded with any kind of material to provide drive-wheel traction.

The blade assembly, $\frac{3}{16}$-in. thick and 23½-in. high, is attached to the plow mounting assembly by a single vertical pin around which the blade may be rotated for angle adjustment. Pushing blocks, located at the base of the plow assembly, enable the plow blade to exert maximum force at the base of the snow load, where the resistance is greatest. A compression coil spring acts as shock absorber.

The snow plow is readily detached as a unit and requires no tools for mounting or dismounting. Two metal legs at the base of the plow assembly permit it to be stored in an upright position. The plow is primarily designed for snow removal, but it may also be used for grading, back-filling and other similar light yard maintenance operations.

 Pages 219-224 removed for Index

IRON AND STEEL ENGINEER INDEX FOR 1952

Herewith is presented the index of all authors and papers published in the IRON AND STEEL ENGINEER for the year 1952

LIST OF AUTHORS

A

ANDERSON, GEORGE C. — "Design and Operation of Electric Weld Pipe Mill at National Tube's National Works," May, 1952, Page 96.

B

BALL, H. W. — "Some Developments in Open Hearth Charging Machines," April, 1952, Page 90.
BARNES, C. O. — "How to Select a Hoist for the Job," December, 1952, Page 111.
BEEMAN, D. L. — "A-C Power Distribution in Steel Plants," September, 1952, Page 140.
BECHTEL, L. D. and CROFT, G. M. — "Combustion and Fine Grinding with the Jet Mill," October, 1952, Page 61.
BISHOP, C. A. — "Some Experience with Air Pollution Abatement in the Steel Industry," December, 1952, Page 122.
BLACK, W. A. — "Electrical Laboratory in a Steel Corporation, The," July, 1952, Page 95.
BLANKENBEKER, E. L. — "Characteristics and Operation of Coal and Ore Bridges," May, 1952, Page 102.
BLOM, K. A. — "Accurate Steel Mill Weighing," May, 1952, Page 55.
BRASSERT, JAMES E. and RAICK, DR. JULIEN O. — "Injection of Oxygen-Reformed Natural Gas and Fuel Oil Into the Blast Furnace," December, 1952, Page 75.
BROWNELL, LLOYD E. and CLAUSS, FRANCIS J. — "Effect of CaO:MgO Ratio in the Neutralization of Pickle Liquor," March, 1952, Page 63.
BRYAN, R. G. — "Control of Multi-Fuel Fired Open Hearth Furnaces," August, 1952, Page 62.
BUNDY, O. M. — "Arc Quenching in Industrial Control," April, 1952, Page 84.
BURTON, CARLYLE R. — "Quality Control of Lubricants," April, 1952, Page 59.
BUTLER, J. E. and SMITH, WM. P. — Temper Mill Symposium — "Power Requirements," June, 1952, Page 87.

C

CARLSON, J. R. — "Modern Hydraulic Applications," March, 1952, Page 94.
CAUGER, E. H. and STAMM, J. C., JR. — "Operative Results of One-Way Fired Recuperative Soaking Pits," December, 1952, Page 98.
CLAUSS, FRANCIS J. and BROWNELL, LLOYD E. — "Effect of CaO:MgO Ratio in the Neutralization of Pickle Liquor," March, 1952, Page 63.
COLEMAN, L. H. — "Fuel-Air Ratio Controls for the Steel Industry," August, 1952, Page 64.
COMPONDU, DOUGLAS H. — "Application of Bentone Lubricants," September, 1952, Page 165.
CROFT, G. M. and BECHTEL, L. D. — "Combustion and Fine Grinding with the Jet Mill," October, 1952, Page 61.

D

DEEGAN, J. E. — "Experiences with Castable and Rammed Refractories," May, 1952, Page 79.
DURRELL, W. H. — "Development of Quebec-Labrador Iron Ore," November, 1952, Page 87.

E

EKWALL, CARL — "Submerged Arc Welding at Atlas Steels, Ltd.," October, 1952, Page 55.

F

FAYLES, ROBERT R. — "Application of Rammed and Castable Refractories in Steel Mills," May, 1952, Page 79.
FENNELL, FRANK C. — "Emergency Drive Arrangements for Blooming Mill Auxiliaries," March, 1952, Page 82.
FINDLAY, GEORGE — "Reconditioning Air Filter Oils," September, 1952, Page 160.
FISHER, W. ROSS — "Training Maintenance Personnel," September, 1952, Page 177.
FLUGGE, S. L. — "Plate Qualities Required in Can Manufacturing," December, 1952, Page 127.
FROMM, O. M. — "Submerged Arc Welding," September, 1952, Page 100.

G

GOCKSTETTER, GEORGE J. — "Open Hearth Furnace Controls," August, 1952, Page 57.
GREEN, JOHN R. — "Control Systems for Improved Open Hearth Operation," August, 1952, Page 66.
GRIFFITHS, A. H. — "Operation of a 12-in. Continuous Bar Mill," November, 1952, Page 55.

H

HALTER, A. C., SELLERS, J. F., and PEEPLES, R. M. — Temper Mill Symposium — "Temper Rolling," June, 1952, Page 76.
HAND, C. R. — "Functions of the Lubricating Engineer," February, 1952, Page 85.
HARRIS, W. R. — "Developments in Electrical Drives for Steel Mill Applications," December, 1952, Page 69.
HARRIS, W. R. — "Operating Experience with Regulating Systems for the Steel Industry," October, 1952, Page 113.
HARRY, ROBERT W. — "Telescopic Ram Pit Cranes," April, 1952, Page 94.
HEATH, H. G. — "Control of Demand and Power Factor on Electric Arc Furnaces," October, 1952, Page 78.
HELM, H. B. — "Symposium on Soaking Pits — At Indiana Harbor Works, Youngstown Sheet & Tube Co.," June, 1952, Page 99.
HERASIMCHUK, MICHAEL V. — "Metallurgical Tips for the Maintenance Man," September, 1952, Page 73.
HEROLD, EDGAR — "Rolling Characteristics of Various Steels," January, 1952, Page 55.
HOLLAND, WARD — "Modernizing Lubrication of Old Mills," May, 1952, Page 76.
HOLMQUIST, J. L. — "Investigation of the Piercing Process by Means of Model Wax Billets," December, 1952, Page 53.
HORKO, WILLIAM N. — "Experiences with Refractory Concrete," May, 1952, Page 83.
HYBARGER, HUGH K. — "Spring End Trucks on Steel Mill Cranes," April, 1952, Page 102.

J

JACKSON, A. — "Effect of Ingot Mold Design on Mold Life," April, 1952, Page 115.
JACQUART, H. F. — "Planned Maintenance of Blooming Mills," December, 1952, Page 118.
JEWART, CHARLES N. and KRANER, HOBERT M. — "Heating up Open Hearth Furnaces After Rebuilding," December, 1952, Page 113.
JOHNSTON, S. S. — "Differential Thickness Coating on Electrolytic Tinplate," May, 1952, Page 72.
JONES, S. H. — "Btu Control," August, 1952, Page 65.

K

KAHL, W. H. — "Multiple Burners for Firing the Open Hearth Furnace," August, 1952, Page 55.
KAUFMANN, R. H. — "Neutral Grounding of Low-Voltage Systems," February, 1952, Page 96.
KEENE, WALTER L. — "An Introduction to Clad Metals," March, 1952, Page 109.
KENDALL, CARTER — "Accident Control in Rolling Mills," November, 1952, Page 98.
KING, A. D. — "Productive Electrical Maintenance," September, 1952, Page 173.

KING, L. W., PETERSON, E. T., and PETERSON, E. C. — "Small Two-High Reversing Mills for the Rolling of Semi-Finished Products," October, 1952, Page 69.
KLEIS, GUY — "Industrial Training for Professional Development," June, 1952, Page 70.
KNUST, H. RUSSELL — "Crane Runway Maintenance," September, 1952, Page 84.
KRANER, HOBERT M. and JEWART, CHARLES N. — "Heating up Open Hearth Furnaces After Rebuilding," December, 1952, Page 113.
KRITSCHER, A. F. — "High Temperature — High Speed Heating for Steel Rounds," March, 1952, Page 55.
KROUSE, HARVEY — "Viscosity Control of Fuel for Open Hearths," July, 1952, Page 78.
KUKA, K. S. — "Engineered Protective Grounding for Steel Plants," May, 1952, Page 88.
KUKA, K. S. — "Remote Control of an Ingot Buggy with Three Motions," July, 1952, Page 121.

L

LAMBERT, C. S. — "Descaling of Carbon Steels in Modern Merchant Mill Practice," February, 1952, Page 59.
LARSON, H. E. — "Developments in D-C Drives for Hot Strip Mill Runout Tables and Coilers," July, 1952, Page 55.
LARSON, H. E. — "Mercury-Arc Rectifiers for Main Roll Drives," November, 1952, Page 61.
LAYTON, C. H. — "Wire Rope Lubrication," September, 1952, Page 167.
LEBENS, JOHN C. — "Increased Interrupting Capacity in Fuses," August 1952, Page 70.
LEX, W. I. — "Selection and Maintenance of Wire Rope," February, 1952, Page 73.
LITTLEWOOD, C. H. — "Crane Limit Switch Failures," April, 1952, Page 100.
LOEWY, ERWIN — "Latest Developments in the Extrusion of Metals," April, 1952, Page 65.
LORD, CARLETON — "Has Industrial Tractor Design Kept Pace with Steel Mill Operating Requirements," March, 1952, Page 75.
LYKINS, J. D. — "Standardization in the Lubrication Department," September, 1952, Page 155.

M

McGEARY, D. J. — "Avoiding Trouble in Soaking Pit Operation," October, 1952, Page 92.
McLOUGHLIN, T. J. — "Attainment of Maximum Open Hearth Production, The," November, 1952, Page 123.
McQUAID, H. W. — "Comparative Economics of the Electric Furnace and Open Hearth," January, 1952, Page 85.
MADSEN, I. E. — "Developments in the Iron and Steel Industry During 1951," January, 1952, Page 103.
MALCOLM, GEORGE — "Stainless Steel Product Standards," January, 1952, Page 70.
MATHIAS, G. E. and WICKERHAM, W. R. — "Modern Crane Control for Steel Plants," November, 1952, Page 106.
MILLER, W. E. and ROTHE, F. S. — "Selection and Analysis of Regulating Systems for Mill Drives," December, 1952, Page 81.
MOHLER, W. H. — "Processing Inquiries and Orders for New Hot Rolled Sections," February, 1952, Page 104.
MORTON, HARRY — "Modern Open Hearth Control," August, 1952, Page 68.
MOSES, LOUIS — "Delivery of Torque to Rolls," June, 1952, Page 55.
MULLER, H. N. — "Long Range Look at Engineering Manpower," June, 1952, Page 66.

P

PEARSON, W. J. — "Modern Machine Tools for the Steel Plant," September, 1952, Page 182.
PEEPLES, R. M., HALTER, A. C., and SELLERS, J. F. — Temper Mill Symposium — "Temper Rolling," June, 1952, Page 76.
PETERS, W. A. — "Fuel Oil Atomization with Natural Gas," August, 1952, Page 61.
PETERSON, E. C., KING, L. W., and PETERSON, E. T. — "Small Two-High Reversing Mills for the Rolling of Semi-Finished Products," October, 1952, Page 69.
PETERSON, E. T., PETERSON, E. C., and KING, L. W. — "Small Two-High Reversing Mills for the Rolling of Semi-Finished Products," October, 1952, Page 69.
POOLE, H. W. — "Electronics in the Steel Industry ... Past, Present and Future," January, 1952, Page 62.
POWEL, R. N. — "Symposium on Soaking Pits — At Wisconsin Steel Works," June, 1952, Page 100.
PRICE, LEWIS — "Code Interpretations and Conductor Selection for Cranes and Hoists," November, 1952, Page 130.
PRIMM, G. — "Symposium on Soaking Pits — At South Works," June, 1952, Page 98.

R

RAICK, DR. JULIEN O. and BRASSERT, JAMES E. — "Injection of Oxygen-Reformed Natural Gas and Fuel Oil Into the Blast Furnace," December, 1952, Page 75.
REESE, M. F. — "Realigning Crane Runways in an Open Hearth Building," September, 1952, Page 93.
REID, WARREN — "Selecting Drive Motors for Flying Shears," February, 1952, Page 81.
RENDLEMAN, NORMAN and WILSON, A. — "Rendleman Rod Mill, The," August, 1952, Page 77.
RIGBY, JOSEPH A. — "Spray Lubrication of Open Gears," July, 1952, Page 87.
ROTHE, F. S. and MILLER, W. E. — "Selection and Analysis of Regulating Systems for Mill Drives," December, 1952, Page 81.

S

SAUER, A. R. — "Safety Analyses — An Aid to On-The-Job Instruction," August, 1952, Page 133.
SCHAEFFER, C. M. — "New Developments in Lubrication Practice," September, 1952, Page 106.
SCHEER, GEORGE B. — "Rectifier Applications on Steel Mill Drives," October, 1952, Page 107.
SCHEFE, FRED K. — "Operating and Economic Aspects of High Speed Tandem Cold Reduction Mills," March, 1952, Page 103.
SCHLOSSBERG, V. E. — "Report on Mill Motor Brake Standardization," December, 1952, Page 133.
SCHUSTER, L. K. and SPRING, SAMUEL — "Phosphate Coatings as Lubricants in the Severe Cold Forming of Metals," May, 1952, Page 64.
SEAVER, JAY J. — "Cleaning Industrial Gases," October, 1952, Page 84.
SEBALD, W. W. — "Today's Challenge to Management," May, 1952, Page 118.
SELLERS, J. F., PEEPLES, R. M., and HALTER, A. C. — Temper Mill Symposium — "Temper Rollings," June, 1952, Page 76.
SIMES, R. J. — "Hydro-Electric Controls for Three-High Mills and Tables," July, 1952, Page 106.
SIMON, BERT — "Metallizing and Its Functions," September, 1952, Page 112.
SINGLETON, P. C. — "Symposium on Soaking Pits — At Inland Steel Co., East Chicago, Inc.," June, 1952, Page 101.
SODERBERG, JR., C. R. — "Industrial Applications of Sonic Energy," February, 1952, Page 87.
SMALL, B. R. — "Heat Relief in Industry," April, 1952, Page 71.
SMITH, WM. P. and BUTLER, J. E. — Temper Mill Symposium — "Power Requirements," June, 1952, Page 87.
SPRING, SAMUEL and SCHUSTER, L. K. — "Phosphate Coatings as Lubricants in the Severe Cold Forming of Metals," May, 1952, Page 64.
STAFFORD, D. E. — "Developments in Coils and Insulating Materials," October, 1952, Page 97.
STAMM, J. C., JR. and CAUGER, E. H. — "Operative Results of One-Way Fired Recuperative Soaking Pits," December, 1952, Page 98.
STOLZ, JOHN J. — "Crane Wheel Tread Contours," October, 1952, Page 101.
SUESS, TH. E. — "Production of Steel by the Oxygen-Impingement Process," March, 1952, Page 91.
SUTHERLAND, JAMES K. — "Steel and Industrial Relations Grow Together," June, 1952, Page 111.

T

TRANTER, G. D. — "Developing Increased Capacity at Armco's Middletown Division," November, 1952, Page 90.

V

VAJDA, STEPHEN — "Open Hearth Dust Control," July, 1952, Page 111.
VAN MATER, LAURANCE F. — "Heating Steel in a Specialty Mill," November, 1952, Page 74.
VOICE, E. W. — "Calculations on Carbon Hearths for Blast Furnaces," July, 1952, Page 125.
VONADA, E. E. — "Multiple Generators for Processing Lines," November, 1952, Page 77.

W

WHITELEY, N. I. — "Steel Mill Lubrication — Past, Present and Future," September, 1952, Page 152.
WHITTEN, J. L. — "Annealing in the Narrow Strip Mills," July, 1952, Page 84.
WICK, RICHARD M. — "Engineering Applications for Chromium Plating," September, 1952, Page 109.
WICKERHAM, W. R. and MATHIAS, G. E. — "Modern Crane Control for Steel Plants," November, 1952, Page 100.
WILSON, A. and RENDLEMAN, NORMAN — "Rendleman Rod Mill, The," August, 1952, Page 77.
WILSON, LEE — "Coil Annealing," February, 1952, Page 66.
WILSON, W. B. — "Combustion Gas Turbines," August, 1952, Page 92.
WOLFENSPERGER, R. E. — "Advantages of Rammed and Cast Refractories for Steel Plant Use," May, 1952, Page 84.

Z

ZIPF, FRANK — "Roll Turning with Tracer Controlled Lathe," April, 1952, Page 55.
ZITTEL, T. O. — "Air Cleaning for Motor Rooms," January, 1952, Page 73.

LIST OF SUBJECTS

A

"A-C Power Distribution in Steel Plants" — By D. L. BEEMAN, September, 1952, Page 140.
"Accident Control in Rolling Mills" — By CARTER KENDALL, November, 1952, Page 98.
"Accurate Steel Mill Weighing" — By K. A. BLOM, May, 1952, Page 55.
"Advantages of Rammed and Cast Refractories for Steel Plant Use" — By R. E. WOLFENSPERGER, May, 1952, Page 84.
"Air Cleaning for Motor Rooms" — By T. O. ZITTEL, January, 1952, Page 73.
"Air Filter Oils, Reconditioning" — By GEORGE FINDLAY, September, 1952, Page 160.
"Air Pollution Abatement in the Steel Industry, Some Experience with" — By C. A. BISHOP, December, 1952, Page 122.
"AISE Standard No. 12, D-C Mill Motor Brake Standards" — December, 1952, Page 131.
"AISE Standard No. 9, Specifications for Design of Hot Metal Ladles" — March, 1952, following page 120.
"American Iron and Steel Institute, Technical Program of The" — August, 1952, Page 111.
"Annealing, Coil" — By LEE WILSON, February, 1952, Page 66.
"Annealing for Narrow Strip Mills" — By J. L. WHITTEN, August, 1952, Page 84.
"Application of Bentone Lubricants" — By D. H. COMPONDU, September, 1952, Page 165.
"Application of Rammed and Castable Refractories in Steel Mills" — By ROBERT R. FAYLES, May, 1952, Page 79.
"Arc Furnaces, Control of Demand and Power Factor on Electric" — By H. G. HEATH, October, 1952, Page 78.
"Arc Quenching in Industrial Control" — By O. M. BUNDY, April, 1952, Page 84.
"Arc Welding at Atlas Steels, Ltd., Submerged" — By CARL EKWALL, October, 1952, Page 55.
"Armco's Middletown Division, Developing Increased Capacity at" — By G. D. TRANTER, November, 1952, Page 90.
"Attainment of Maximum Open Hearth Production, The" — By T. J. McLOUGHLIN, November, 1952, Page 123.
"Avoiding Trouble in Soaking Pit Operation" — By D. J. McGEARY, October, 1952, Page 92.
"Axial Compressor for Blast Furnace Blowing, Discussion of the" — January, 1952, Page 79.

B

"Bar Mill, Operation of a 12-in. Continuous" — By A. H. GRIFFITHS, November, 1952, Page 55.
"Blast Furnace Blowing, Discussion of the Axial Compressor for" — January, 1952, Page 79.
"Blast Furnace, Injection of Oxygen-Reformed Natural Gas and Fuel Oil Into the" — By DR. JULIEN O. RAICK and JAMES E. BRASSERT, December, 1952, Page 75.
"Blast Furnaces, Calculations on Carbon Hearths for" — By E. W. VOICE, July, 1952, Page 125.
"Blooming Mill Auxiliaries, Emergency Drive Arrangements for" — By F. C. FENNELL, March, 1952, Page 82.
"Blooming Mills, Planned Maintenance of" — By H. F. JACQUART, December, 1952, Page 118.
"Brake Standardization, Report on Mill Motor" — By V. E. SCHLOSSBERG, December, 1952, Page 133.
"Brake Standard, D-C Mill Motor AISE Standard No. 12" — December, 1952, Page 132.
"Bridges, Characteristics and Operation of Coal and Ore" — By E. L. BLANKENBEKER, May, 1952, Page 102.
"Btu Control" — By S. H. JONES, August, 1952, Page 65.
"Burners for Firing the Open Hearth Furnace, Multiple" — By W. H. KAHL, August, 1952, Page 55.
"By-Products in 1951, Coke and" — November, 1952, Page 116.

C

"Calculations on Carbon Hearths for Blast Furnaces" — By E. W. VOICE, July, 1952, Page 125.
"Can Manufacturing, Plate Qualities Required in" — By S. L. FLUGGE, December, 1952, Page 127.
"Carbon Hearths for Blast Furnaces, Calculations on" — By E. W. VOICE, July, 1952, Page 125.
"Characteristics and Operation of Coal and Ore Bridges" — By E. L. BLANKENBEKER, May, 1952, Page 102.
"Charging Machines, Some Developments in Open Hearth" — By H. W. BALL, April, 1952, Page 90.
"Chromium Plating, Engineering Applications for" — By DR. RICHARD WICK, September, 1952, Page 109.
"Clad Metals, An Introduction to" — By WALTER L. KEENE, March, 1952, Page 109.
"Cleaning Industrial Gases" — By JAY J. SEAVER, October, 1952, Page 84.
"Coal and Ore Bridges, Characteristics and Operation of" — By E. L. BLANKENBEKER, May, 1952, Page 102.
"Code Interpretations and Conductor Selection for Cranes and Hoists" — By LEWIS PRICE, November, 1952, Page 130.
"Coil Annealing" — By LEE WILSON, February, 1952, Page 66.
"Coilers, Developments in D-C Drives for Hot Strip Mill Runout Tables and" — By H. E. LARSON, July, 1952, Page 55.
"Coils and Insulating Materials, Developments in" — By D. E. STAFFORD, October, 1952, Page 97.
"Coke and By-Products in 1951" — November, 1952, Page 116.
"Cold Forming of Metals, Phosphate Coatings as Lubricants in the Severe" — By DR. LUDWIG K. SCHUSTER and S. SPRING, May, 1952, Page 64.
"Cold Reduction Mills, Operating and Economic Aspects of High Speed Tandem" — By F. K. SCHEFE, March, 1952, Page 103.
"Combustion and Fine Grinding with the Jet Mill" — By G. M. CROFT and L. D. BECHTEL, October, 1952, Page 61.
"Combustion Gas Turbines" — By W. B. WILSON, August, 1952, Page 92.
"Comparative Economics of the Electric Furnace and Open Hearth" — By H. W. McQUAID, January, 1952, Page 85.
"Conductor Selection for Cranes and Hoists, Code Interpretations and" — By LEWIS PRICE, November, 1952, Page 130.
"Control, Arc Quenching in Industrial" — By O. M. BUNDY, April, 1952, Page 84.
"Control, Btu" — By S. H. JONES, August, 1952, Page 65.
"Control of Demand and Power Factor on Electric Arc Furnaces" — By H. G. HEATH, October, 1952, Page 78.
"Control for Steel Plants, Modern Crane — Alternating Current" — By W. R. WICKERHAM; "Direct Current" — By G. E. MATHIAS, November, 1952, Page 100.
"Control, Modern Open Hearth" — By HARRY MORTON, August, 1952, Page 68.
"Control of Multi-Fuel Fired Open Hearth Furnaces" — By R. G. BRYAN, August, 1952, Page 62.
"Control Systems for Improved Open Hearth Operation" — By JOHN R. GREEN, August, 1952, Page 66.
"Controls for the Steel Industry, Fuel-Air Ratio" — By L. H. COLEMAN, August, 1952, Page 64.
"Controls for Three-High Mills and Tables, Hydro-Electric" — By R. J. SIMES, July, 1952, Page 106.
"Controls, Open Hearth Furnace" — By GEORGE J. GOCKSTETTER, August, 1952, Page 57.
"Crane Limit Switch Failure" — By C. H. LITTLEWOOD, April, 1952, Page 100.
"Crane Control for Steel Plants, Modern — Alternating Current" — By W. R. WICKERHAM; "Direct Current" — By G. E. MATHIAS, November, 1952, Page 100.
"Crane Runway Maintenance" — By H. R. KNUST, September, 1952, Page 84.
"Crane Runways in an Open Hearth Building, Realigning" — By M. F. REESE, JR., September, 1952, Page 93.
"Cranes and Hoists, Code Interpretations and Conductor Selection for" — By LEWIS PRICE, November, 1952, Page 130.
"Cranes, Spring End Trucks on Steel Mill" — By HUGH K. HYBARGER, April, 1952, Page 102.
"Cranes, Telescopic Ram Pit" — By ROBERT W. HARRY, April, 1952, Page 94.
"Crane Wheel Tread Contours" — By JOHN J. STOLZ, October, 1952, Page 101.

D

"D-C Mill Motor Brake Standards, AISE Standard No. 12" — December, 1952, Page 131.
"Delivery of Torque to Rolls" — By LOUIS MOSES, June, 1952, Page 55.
"Descaling of Carbon Steels in Modern Merchant Mill Practice" — By C. S. LAMBERT, February, 1952, Page 59.
"Design and Operation of Electric Weld Pipe Mill at National Tube's Nationa Works" — By G. C. ANDERSON, May, 1952, Page 96.
"Developing Increased Capacity at Armco's Middletown Division" — By G. D. TRANTER, November, 1952, Page 90.
"Development of Quebec-Labrador Iron Ore" — By W. H. DURRELL, November, 1952, Page 87.
"Developments in Coils and Insulating Materials" — By D. E. STAFFORD, October, 1952, Page 97.
"Developments in D-C Drives for Hot Strip Mill Runout Tables and Coilers" — By H. E. LARSON, July, 1952, Page 55.
"Developments in Electrical Drives for Steel Mill Applications" — By W. R. HARRIS, December, 1952, Page 69.
"Developments in the Iron and Steel Industry During 1951" — By I. E. MADSEN, January, 1952, Page 103.
"Differential Thickness Coating on Electrolytic Tinplate" — By S. S. JOHNSTON, May, 1952, Page 72.
"Discussion of the Axial Compressor for Blast Furnace Blowing" — January, 1952, Page 79.
"Drives for Steel Mill Applications, Developments in Electrical Drives" — By W. R. HARRIS, December, 1952, Page 69.
"Drives, Rectifier Applications on Steel Mill" — By GEORGE B. SCHEER, October, 1952, Page 107.
"Drives, Selection and Analysis of Regulating Systems for Mill" — By W. E. MILLER and F. S. ROTHE, December, 1952, Page 81.
"Dust Control, Open Hearth" — By STEPHEN VAJDA, July, 1952, Page 111.

E

"Effect of CaO:MgO Ratio in the Neutralization of Pickle Liquor" — By LLOYD E. BROWNELL and FRANCIS J. CLAUSS, March, 1952, Page 63.
"Effect of Ingot Mold Design on Mold Life" — By A. JACKSON, April, 1952, Page 115.
"Electrical Drives for Steel Mill Applications, Developments" — By W. R. HARRIS, December, 1952, Page 69.
"Electric Arc Furnaces, Control of Demand and Power Factor" — By H. G. HEATH, October, 1952, Page 78.
"Electric Furnace and Open Hearth, Comparative Economics of the" — By H. W. McQUAID, January, 1952, Page 85.
"Electric Weld Pipe Mill at National Tube's National Works, Design and Operation of" — By G. C. ANDERSON, May, 1952, Page 96.
"Electrical Laboratory in A Steel Corporation, The" — By W. A. BLACK, July, 1952, Page 95.
"Electrical Maintenance, Productive" — By A. D. KING, September, 1952, Page 173.
"Electrolytic Tinplate, Differential Thickness Coating on" — By S. S. JOHNSTON, May, 1952, Page 72.
"Electronics in the Steel Industry . . . Past, Present, and Future" — By H. W. POOLE, January, 1952, Page 62.
"Emergency Drive Arrangements for Blooming Mill Auxiliaries" — By F. C. FENNELL, March, 1952, Page 82.
"Engineered Protective Grounding for Steel Plants" — By K. S. KUKA, May, 1952, Page 88.
"Engineering Applications for Chromium Plating" — By DR. RICHARD WICK, September, 1952, Page 109.
"Engineering Manpower, Long Range Look at" — By H. N. MULLER, JR., June, 1952, Page 66.
"Experiences with Castable and Rammed Refractories" — By J. E. DEEGAN, May, 1952, Page 79.
"Experiences with Refractory Concrete" — By WILLIAM N. HORKO, May, 1952, Page 83.
"Extrusion of Metals, Latest Developments in" — By ERWIN LOEWY, April, 1952, Page 65.
"Extrusion Process at Babcock & Wilcox Co., New Tube" — June, 1952, Page 106.

F

"Fuel-Air Ratio Controls for the Steel Industry" — By L. H. COLEMAN, August, 1952, Page 64.
"Fuel Oil Atomization with Natural Gas" — By W. A. PETERS, August, 1952, Page 61.
"Functions of the Lubricating Engineer" — By C. R. HAND, February, 1952, Page 85.
"Furnaces After Rebuilding, Heating up Open Hearth" — By HOBART M. KRANER and CHARLES N. JEWART, December, 1952, Page 113.
"Furnaces, Control of Demand and Power Factor on Electric Arc" — By H. G. HEATH, October, 1952, Page 78.
"Fuses, Increased Interrupting Capacity in" — By JOHN C. LEBENS, August, 1952, Page 70.

G

"Gases, Cleaning Industrial" — By JAY J. SEAVER, October, 1952, Page 84.
"Gas Turbines, Combustion" — By W. B. WILSON, August, 1952, Page 92.
"Generators for Processing Lines, Multiple" — By E. E. VONADA, November, 1952, Page 77.
"Grinding with the Jet Mill, Combustion and Fine" — By G. M. CROFT and L. D. BECHTEL, October, 1952, Page 61.
"Grounding for Steel Plants, Engineered Protective" — By K. S. KUKA, May, 1952, Page 88.
"Grounding of Low-Voltage Systems, Neutral" — By R. H. KAUFMANN, February, 1952, Page 96.

H

"Has Industrial Tractor Design Kept Pace with Steel Mill Operating Requirements?" — By CARLETON LORD, March, 1952, Page 75.
"Heating for Steel Rounds, High Temperature — High Speed" — By A. F. KRITSCHER, March, 1952, Page 55.
"Heating up Open Hearth Furnaces After Rebuilding" — By HOBART M. KRANER and CHARLES N. JEWART, December, 1952, Page 113.
"Heat Relief in Industry" — By BARTLETT R. SMALL, April, 1952, Page 71.
"Heating Steel in a Specialty Mill" — By LAURANCE F. VAN MATER, November, 1952, Page 74.
"High Temperature — High Speed Heating for Steel Rounds" — By A. F. KRITSCHER, March, 1952, Page 55.
"Hoist for the Job, How to Select a" — By C. O. BARNES, December, 1952, Page 111.
"How to Select a Hoist for the Job" — By C. O. BARNES, December, 1952, Page 111.
"Hydraulic Applications, Modern" — By JOHN R. CARLSON, March, 1952, Page 94.
"Hydro-Electric Controls for Three-High Mills and Tables" — By R. J. SIMES, July, 1952, Page 106.

I

"Increased Interrupting Capacity in Fuses" — By JOHN C. LEBENS, August, 1952, Page 70.
"Industrial Applications of Sonic Energy" — By C. RICHARD SODERBERG, JR., February, 1952, Page 87.
"Industrial Relations Grow Together, Steel and" — By JAMES K. SUTHERLAND, June, 1952, Page 111.
"Industrial Training for Professional Development" — By GUY KLEIS, June, 1952, Page 70.
"Ingot Buggy with Three Motions, Remote Control of an" — By K. S. KUKA, July, 1952, Page 121.
"Ingot Mold Design on Mold Life, Effect of" — By A. JACKSON, April, 1952, Page 115.
"Injection of Oxygen-Reformed Natural Gas and Fuel Oil Into the Blast Furnace" — By DR. JULIEN O. RAICK and JAMES E. BRASSERT, December, 1952, Page 75.
"Insulating Materials, Developments in Coils and" — By D. E. STAFFORD, October, 1952, Page 97.
"Introduction to Clad Metals, An" — By WALTER L. KEENE, March, 1952, Page 109.
"Investigation of the Piercing Process by Means of Model Wax Billets" — By J. L. HOLMQUIST, December, 1952, Page 53.
"Iron and Steel Industry During 1951, Developments in the" — By I. E. MADSEN, January, 1952, Page 103.

J

"Jet Mill, Combustion and Fine Grinding with the" — By G. M. CROFT and L. D. BECHTEL, October, 1952, Page 61.

L

"Laboratory in a Steel Corporation, The Electrical" — By W. A. BLACK, July, 1952, Page 95.
"Ladles AISE Standard No. 9, Specifications for Design of Hot Metal" — March, 1952, following page 120.
"Latest Developments in Extrusion of Metals" — By ERWIN LOEWY, April, 1952, Page 65.
"Limit Switch Failures, Crane" — By C. H. LITTLEWOOD, April, 1952, Page 100.
"Long Range Look at Engineering Manpower" — By H. N. MULLER, JR., June, 1952, Page 66.
"Lubricants, Application of Bentone" — By D. H. COMPONDU, September, 1952, Page 165.
"Lubricants in the Severe Cold Forming of Metals, Phosphate Coatings as" — By DR. LUDWIG K. SCHUSTER and S. SPRING, May, 1952, Page 64.
"Lubricants, Quality Control of" — By CARLYLE R. BURTON, April, 1952, Page 59.
"Lubricating Engineer, Functions of the" — By C. R. HAND, February, 1952, Page 85.
"Lubrication Department, Standardization in the" — By J. D. LYKINS, September, 1952, Page 155.
"Lubrication of Old Mills, Modernizing" — By WARD HOLLAND, May, 1952, Page 76.
"Lubrication of Open Gears, Spray" — By JOSEPH A. RIGBY, July, 1952, Page 87.
"Lubrication — Past, Present and Future, Steel Mill" — By N. I. WHITELEY, September, 1952, Page 152.
"Lubrication Practice, New Developments in" — By C. M. SCHAEFFER, September, 1952, Page 106.
"Lubrication, Wire Rope" — By C. H. LAYTON, September, 1952, Page 167.

M

"Machine Tools for the Steel Plant, Modern" — By W. J. PEARSON, September, 1952, Page 182.
"Maintenance, Crane Runway" — By H. R. KNUST, September, 1952, Page 84.
"Maintenance Man, Metallurgical Tips for the" — By M. V. HERASIMCHUK, September, 1952, Page 73.
"Maintenance of Blooming Mills, Planned" — By H. F. JACQUART, December, 1952, Page 118.
"Maintenance Personnel, Training" — By W. ROSS FISHER, September, 1952, Page 177.
"Maintenance, Productive Electrical" — By A. D. KING, September, 1952, Page 173.
"Management, Today's Challenge to" — By W. W. SEBALD, May, 1952, Page 118.
"Mercury Arc Rectifiers for Main Roll Drives" — By H. E. LARSON, November, 1952, Page 61.
"Metallizing and Its Functions" — By B. SIMON, September, 1952, Page 112.
"Metallurgical Tips for the Maintenance Man" — By M. V. HERASIMCHUK, September, 1952, Page 73.
"Mill Auxiliaries, Emergency Drive Arrangements for Blooming" — By F. C. FENNELL, March, 1952, Page 82.
"Mill Drives, Rectifier Applications on Steel" — By GEORGE B. SCHEER, October, 1952, Page 107.

"Mill, Operation of a 12-in. Continuous Bar" — By A. H. GRIFFITHS, November, 1952, Page 55.
"Mill Practice, Descaling of Carbon Steels in Modern Merchant" — By C. S. LAMBERT, February, 1952, Page 59.
"Mill, The Rendleman Rod" — By NORMAN RENDLEMAN and A. WILSON, August, 1952, Page 77.
"Mills and Tables, Hydro-Electric Controls for Three-High" — By R. J. SIMES, July, 1952, Page 106.
"Mills for the Rolling of Semi-Finished Products, Small Two-High Reversing" — By EDWARD T. PETERSON, LEWIS W. KING and EDWARD C. PETERSON, October, 1952, Page 69.
"Mills, Operating and Economic Aspects of High Speed Tandem Cold Reduction" — By F. K. SCHEFE, March, 1952, Page 103.
"Mill Symposium, Temper — Temper Rolling" — By J. F. SELLERS, R. M. PEEPLES and A. C. HALTER; "Power Requirements" — By WM. P. SMITH and J. E. BUTLER, June, 1952, Pages 76 and 87.
"Modern Crane Control for Steel Plants — Alternating Current" — By W. R. WICKERHAM; "Direct Current" — By G. E. MATHIAS, November, 1952, Page 100.
"Modern Machine Tools for the Steel Plant" — By W. J. PEARSON, September, 1952, Page 182.
"Modern Open Hearth Control" — By HARRY MORTON, August, 1952, Page 68.
"Modern Hydraulic Applications" — By JOHN R. CARLSON, March, 1952, Page 94.
"Modernizing Lubrication of Old Mills" — By WARD HOLLAND, May, 1952, Page 76.
"Mold Life, Effect of Ingot Mold Design on" — By A. JACKSON, April, 1952, Page 115.
"Motors for Flying Shears, Selecting Drive" — By WARREN REID, February, 1952, Page 81.
"Motor Rooms, Air Cleaning for" — By T. O. ZITTEL, January, 1952, Page 73.
"Multiple Burners for Firing the Open Hearth Furnace" — By W. H. KAHL, August, 1952, Page 55.
"Multiple Generators for Processing Lines" — By E. E. VONADA, November, 1952, Page 77.

N

"National Tube's National Works, Design and Operation of Electric Weld Pipe Mill at" — By G. C. ANDERSON, May, 1952, Page 96.
"Neutral Grounding of Low-Voltage Systems" — By R. H. KAUFMANN, February, 1952, Page 96.
"Neutralization of Pickle Liquor, Effect of CaO:MgO Ratio in the" — By LLOYD E. BROWNELL and FRANCIS J. CLAUSS, March, 1952, Page 63.
"New Developments in Lubrication Practice" — By C. M. SCHAEFFER, September, 1952, Page 106.
"New Tube Extrusion Process at Babcock & Wilcox Co." — June, 1952, Page 106.
"Oils, Reconditioning Air Filter" — By GEORGE FINDLAY, September, 1952, Page 160.

O

"Open Hearth Charging Machines, Some Developments in" — By H. W. BALL, April, 1952, Page 90.
"Open Hearth, Comparative Economics of the Electric Furnace and" — By H. W. McQUAID, January, 1952, Page 85.
"Open Hearth Control, Modern" — By HARRY MORTON, August, 1952, Page 68.
"Open Hearth Dust Control" — By STEPHEN VAJDA, July, 1952, Page 111.
"Open Hearth Furnace Controls" — By GEORGE J. GOCKSTETTER, August, 1952, Page 57.
"Open Hearth Furnace, Multiple Burners for Firing the" — By W. H. KAHL, August, 1952, Page 55.
"Open Hearth Furnaces After Rebuilding, Heating up" — By HOBERT M. KRANER and CHARLES N. JEWART, December, 1952, Page 113.
"Open Hearth Furnaces, Control of Multi-Fuel Fired" — By R. G. BRYAN, August, 1952, Page 62.
"Open Hearth Operation, Control Systems for Improved" — By JOHN R. GREEN, August, 1952, Page 66.
"Open Hearth Production, The Attainment of Maximum" — By T. J. McLOUGHLIN, November, 1952, Page 123.
"Open Hearths, Viscosity Control of Fuel for" — By HARVEY KROUSE, July, 1952, Page 78.
"Operating and Economic Aspects of High Speed Tandem Cold Reduction Mills" — By F. K. SCHEFE, March, 1952, Page 103.
"Operating Experience with Regulating Systems for the Steel Industry" — By W R. HARRIS, October, 1952, Page 113.
"Operation of a 12-in. Continuous Bar Mill" — By A. H. GRIFFITHS, November, 1952, Page 55.
"Operative Results of One-Way Fired Recuperative Soaking Pits" — By E. H. CAUGER and J. C. STAMM, JR., December, 1952, Page 98.
"Orders for New Hot Rolled Sections, Processing Inquiries and" — By W. H. MOHLER, February, 1952, Page 104.
"Ore Bridges, Characteristics and Operation of Coal and" — By E. L. BLANKENBEKER, May, 1952, Page 102.
"Ore, Development of Quebec-Labrador Iron" — By W. H. DURRELL, November, 1952, Page 87.
"Oxygen-Impingement Process, Production of Steel by the" — By TH. E. SUESS, March, 1952, Page 91.
"Oxygen-Reformed Natural Gas and Fuel Oil Into the Blast Furnace, Injection of" — By DR. JULIEN O. RAICK and JAMES E. BRASSERT, December, 1952, Page 75.

P

"Phosphate Coatings as Lubricants in the Severe Cold Forming of Metals" — By DR. LUDWIG K. SCHUSTER and S. SPRING, May, 1952, Page 64.
"Pickle Liquor, Effect of CaO:MgO Ratio in the Neutralization of Pickle Liquor" — By LLOYD E. BROWNELL and FRANCIS J. CLAUSS, March, 1952, Page 63.
"Piercing Process by Means of Model Wax Billets, Investigation of the" — By J. L. HOLMQUIST, December, 1952, Page 53.
"Pipe Mill at National Tube's National Works, Design and Operation of Electric Weld" — By G. C. ANDERSON, May, 1952, Page 96.
"Planned Maintenance of Blooming Mills" — By H. F. JACQUART, December, 1952, Page 118.
"Plate Qualities Required in Can Manufacturing" — By S. L. FLUGGE, December, 1952, Page 127
"Pollution Abatement in the Steel Industry, Some Experience with Air" — By C. A. BISHOP, December, 1952, Page 122.
"Power Distribution in Steel Plants, A-C" — By D. L. BEEMAN, September, 1952, Page 140.
"Processing Inquiries and Orders for New Hot Rolled Sections" — By W. H. MOHLER, February, 1952, Page 104.
"Production of Steel by the Oxygen-Impingement Process" — By TH. E. SUESS, March, 1952, Page 91.
"Productive Electrical Maintenance" — By A. D. KING, September, 1952, Page 173.

Q

"Quality Control of Lubricants" — By CARLYLE R. BURTON, April, 1952, Page 59.

R

"Realigning Crane Runways in an Open Hearth Building" — By M. F. REESE, JR., September, 1952, Page 93.
"Reconditioning Air Filter Oils" — By GEORGE FINDLAY, September, 1952, Page 160.
"Rectifier Applications on Steel Mill Drives" — By GEORGE B. SCHEER, October, 1952, Page 107.
"Rectifiers for Main Roll Drives, Mercury Arc" — By H. E. LARSON, November, 1952, Page 61.
"Refractories, Experiences with Castable and Rammed" — By J. E. DEEGAN, May, 1952, Page 79.
"Refractories for Steel Plant Use, Advantages of Rammed and Cast" — By R. E. WOLFENSPERGER, May, 1952, Page 84.
"Refractories in Steel Mills, Application of Rammed and Castable" — By ROBERT R. FAYLES, May, 1952, Page 79.
"Refractory Concrete, Experiences with" — By WILLIAM N. HORKO, May, 1952, Page 83.
"Regulating System for Mill Drives, Selection and Analysis of" — By W. E. MILLER and F. S. ROTHE, December, 1952, Page 81.
"Regulating Systems for the Steel Industry, Operating Experience with" — By W. R. HARRIS, October, 1952, Page 113.
"Remote Control of an Ingot Buggy with Three Motions" — By K. S. KUKA, July, 1952, Page 121.
"Rendleman Rod Mill, The" — By NORMAN RENDLEMAN and A. WILSON, August, 1952, Page 77.
"Report on Mill Motor Brake Standardization" — By V. E. SCHLOSSBERG, December, 1952, Page 133.
"Reversing Mills for the Rolling of Semi-Finished Products, Small Two-High" — By EDWARD T. PETERSON, LEWIS W. KING and EDWARD C. PETERSON, October, 1952, Page 69.
"Rod Mill, The Rendleman" — By NORMAN RENDLEMAN and A. WILSON, August, 1952, Page 77.
"Rolling Mills, Accident Control in" — By CARTER KENDALL, November, 1952, Page 98.
"Rolls, Delivery of Torque to" — By LOUIS MOSES, June, 1952, Page 55.
"Roll Turning with Tracer Controlled Lathe" — By FRANK F. ZIPF, April, 1952, Page 55.
"Rolling Characteristics of Various Steels" — By EDGAR M. D. HEROLD, January, 1952, Page 55.
"Rope Lubrication, Wire" — By C. H. LAYTON, September, 1952, Page 167.
"Rope, Selection and Maintenance of Wire" — By W. I. LEX, February, 1952, Page 73.

"Runout Tables and Coilers, Developments in D-C Drives for Hot Strip Mill" — By H. E. LARSON, July, 1952, Page 55.
"Runway Maintenance, Crane" — By H. R. KNUST, September, 1952, Page 84.
"Runways in an Open Hearth Building, Realigning Crane" — By M. F. REESE, JR., September, 1952, Page 93.

S

"Safety Analyses — An Aid to On-The-Job Instruction" — By A. R. SAUER, August, 1952, Page 133.
"Selecting Drive Motors for Flying Shears" — By WARREN REID, February, 1952, Page 81.
"Selection and Analysis of Regulating Systems for Mill Drives" — By W. E. MILLER and F. S. ROTHE, December, 1952, Page 81.
"Selection and Maintenance of Wire Rope" — By W. I. LEX, February, 1952, Page 73.
"Shears, Selecting Drive Motors for Flying" — By WARREN REID, February, 1952, Page 81.
"Small Two-High Reversing Mills for the Rolling of Semi-Finished Products" — By EDWARD T. PETERSON, LEWIS W. KING and EDWARD C. PETERSON, October, 1952, Page 69.
"Soaking Pit Operation, Avoiding Trouble in" — By D. J. McGEARY, October, 1952, Page 92.
"Soaking Pits, Operative Results of One-Way Fired Recuperative" — By E. H. CAUGER and J. C. STAMM, JR., December, 1952, Page 98.
"Soaking Pits, Symposium on" — By G. PRIMM, H. B. HELM, R. N. POWEL, and P. C. SINGLETON, June, 1952, Page 98.
"Some Developments in Open Hearth Charging Machines" — By H. W. BALL, April, 1952, Page 90.
"Some Experience with Air Pollution Abatement in the Steel Industry" — By C. A. BISHOP, December, 1952, Page 122.
"Sonic Energy, Industrial Applications of" — By C. RICHARD SODERBERG, JR., February, 1952, Page 87.
"Specifications for Design of Hot Metal Ladles AISE Standard No. 9" — March, 1952, following page 120.
"Spray Lubrication of Open Gears" — By JOSEPH A. RIGBY, July, 1952, Page 87.
"Spring End Trucks on Steel Mill Cranes" — By HUGH K. HYBARGER, April, 1952, Page 102.
"Standardization in the Lubrication Department" — By J. D. LYKINS, September, 1952, Page 155.
"Standardization, Report on Mill Motor Brake" — By V. E. SCHLOSSBERG, December, 1952, Page 133.
"Standard No. 9, Specifications for Design of Hot Metal Ladles AISE" — March, 1952, following page 120.
"Standard No. 12, D-C Mill Motor Brake Standards AISE" — December, 1952, Page 131.
"Stainless Steel Product Standards" — By GEORGE N. MALCOLM, January, 1952, Page 70.
"Steel and Industrial Relations Grow Together" — By JAMES K. SUTHERLAND, June, 1952, Page 111.
"Steel by the Oxygen-Impingement Process, Production of" — By TH. E. SUESS, March, 1952, Page 91.
"Steel in a Specialty Mill, Heating" — By LAURANCE F. VAN MATER, November, 1952, Page 74.
"Steel Mill Lubrication — Past, Present and Future" — By N. I. WHITELEY, September, 1952, Page 152.
"Steel Product Standards, Stainless" — By GEORGE N. MALCOLM, January, 1952, Page 70.
"Steels in Modern Merchant Mill Practice, Descaling of Carbon" — By C. S. LAMBERT, February, 1952, Page 59.
"Steels, Rolling Characteristics of Various" — By EDGAR M. D. HEROLD, January, 1952, Page 55.
"Steel Industry During 1951, Developments in the Iron and" — By I. E. MADSEN, January, 1952, Page 103.
"Strip Mills, Annealing for Narrow" — By J. L. WHITTEN, August, 1952, Page 84.
"Submerged Arc Welding" — By O. M. FROMM, September, 1952, Page 100.
"Submerged Arc Welding at Atlas Steels, Ltd." — By CARL EKWALL, October, 1952, Page 55.
"Symposium on Soaking Pits" — By G. PRIMM, H. B. HELM, R. N. POWEL and P. C. SINGLETON, June, 1952, Page 98.

T

"Tables and Coilers, Developments in D-C Drives for Hot Strip Mill Runout" — By H. E. LARSON, July, 1952, Page 55.
"Technical Program of the American Iron and Steel Institute" — August, 1952, Page 111.
"Telescopic Ram Pit Cranes" — By ROBERT W. HARRY, April, 1952, Page 94.
"Temper Mill Symposium — Temper Rolling" — By J. F. SELLERS, R. M. PEEPLES and A. C. HALTER; "Power Requirements" — By WM. P. SMITH, and J. E. BUTLER, June, 1952, Pages 76 and 87.
"Tinplate, Differential Thickness Coating on Electrolytic" — By S. S. JOHNSTON, May, 1952, Page 72.
"Today's Challenge to Management" — By W. W. SEBALD, May, 1952, Page 118.
"Tracer Controlled Lathe, Roll Turning with" — By FRANK F. ZIPF, April, 1952, Page 55.
"Tractor Design Kept Pace with Steel Mill Operating Requirements, Has Industrial" — By CARLETON LORD, March, 1952, Page 75.
"Training for Professional Development, Industrial" — By GUY KLEIS, June, 1952, Page 70.
"Training Maintenance Personnel" — By W. ROSS FISHER, September, 1952, Page 177.
"Tube Extrusion Process at Babcock & Wilcox Co., New" — June, 1952, Page 106.
"Turbines, Combustion Gas" — By W. B. WILSON, August, 1952, Page 92.

V

"Viscosity Control of Fuel for Open Hearths" — By HARVEY KROUSE, July 1952, Page 78.

W

"Weighing, Accurate Steel Mill" — By K. A. BLOM, May, 1952, Page 55.
"Welding at Atlas Steels, Ltd., Submerged Arc" — By CARL EKWALL, October, 1952, Page 55.
"Welding, Submerged Arc" — By O. M. FROMM, September, 1952, Page 100.
"Wheel Tread Contours, Crane" — By JOHN J. STOLZ, October, 1952, Page 101.
"Wire Rope Lubrication" — By C. H. LAYTON, September, 1952, Page 167.
"Wire Rope, Selection and Maintenance of" — By W. I. LEX, February, 1952 Page 73.

CLEAN WATER IN YOUR PLANT

Prolongs the working life span of all equipment that is cooled, heated or actuated by water.

Adams Poro-Stone filters convert your turbid supply to water of any degree of clarity you require. Used with or without filter aid, operated manually or automatically, Poro-Stone filters may be spotted throughout the plant at points of need or centrally installed for plantwide distribution.

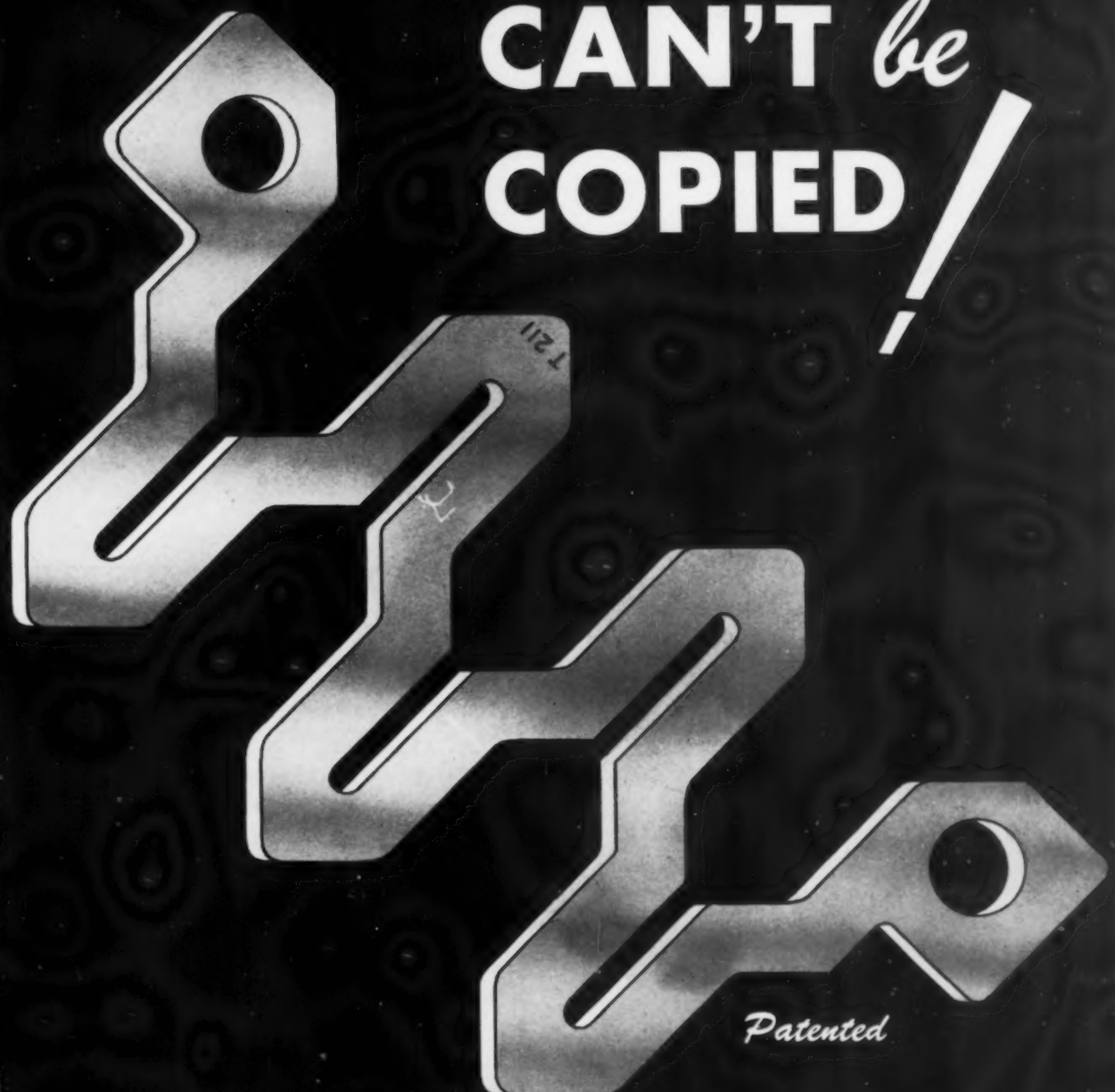
Complete, packaged Adams filtration plants include filter aid precoat tank, continuous filter aid feeder, pressure backwash system, pump, valves and piping.

WRITE FOR BULLETIN 691

R. P. ADAMS CO., INC.

223 E. PARK DRIVE, BUFFALO 17, N. Y.

THE *Shape . . .* CAN'T *be* COPIED!



Patented

The Nonbreakable Steel Grid Resistor

Book Reviews . . .

▲ **"Elasticity in Engineering,"** by Ernest E. Sechler, 6 × 9 in., 419 pp, is aimed primarily at filling the needs of the aeronautical engineer. However, engineers in the civil and mechanical engineering fields will find it informative since the volume discusses material that is necessary for an understanding of the fundamental theories of stress and deformation of elastic bodies under load. The first part of the book deals with the fundamental equations and assumptions underlying the whole field of elasticity. The second portion discusses the application of these principles to solve the problems of stable and instable structures. Published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., the book is priced at $8.50.

▲ **"Theory of Elasticity and Plasticity,"** by H. M. Westergaard, 5½ × 8½ in., 176 pp, $5.00, published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., though theoretical, deals with the subject from the point of view of the engineer. Chapters are devoted to stress, strain, Hooke's law, the basic equation of elasticity, laws of plasticity, strain potential, hollow cylinders and spheres, inertia forces, thermal stresses, the Galerkin vector, and effects of a single force. The discussion for the most part is limited to loads and stresses in equilibrium within the realm of statics.

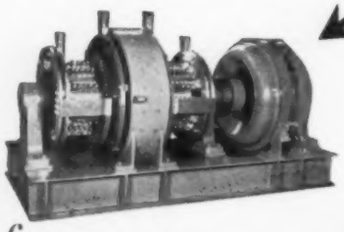
▲ **"Fatigue and Fracture of Metals,"** edited by William M. Murray, 6 × 9 in., 313 pp, is a recently-published collection of papers presented at a special conference held at the Massachusetts Institute of Technology. This symposium considers the internal mechanisms probably involved in fatigue damage, the significance of various metallurgical phenomena to fatigue, and the potential usefulness of different research methods to disclose more about the mechanism behind the phenomenon itself and about ways of countering it in design. Specific recommendations are presented for investigation of the subject. The book may be obtained from John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y., price $6.00.

▲ **"Manual of Accident Prevention in Construction,"** 4th revised edition, 6 x 9 in., 257 pp, has been published by The Associated General Contractors of America, Inc., 1227 Munsey Bldg., Washington 4, D. C. As in previous editions the text is a compilation of safety practices in construction work, emphasizing the costly result of incorrect and unsafe methods. New sections have been included dealing with arc welding, gas welding and cutting, power saws, flammable gases and liquids, motor graders, bulldozers and tractors, and boats and barges. A common-sense approach to the subject of accident prevention, coupled with the many illustrations, specifications, and simplified text make this volume a valuable addition to the industrial library.

▲ **"Textbook of Engineering Materials,"** by Melvin Nord, 518 pp, 6 x 9 in., price $6.50 has been recently published by John Wiley & Sons, Inc.,

COLUMBIA

MOTOR GENERATORS



for
- Electroplating
- Anodizing
- Electrocleaning
- Electropolishing

TONG TEST
A. C. — D. C.
AMMETERS

- TANK RHEOSTATS
- REVERSING SWITCHES

Write for Descriptive Bulletins

COLUMBIA ELECTRIC MFG. CO.
4543 HAMILTON AVE. CLEVELAND 14, OHIO

I Wish . . .

to enter one year's subscription for the IRON AND STEEL ENGINEER at $7.50 per year:

☐ Check enclosed

☐ Bill me later

I desire information on membership in the Association of Iron and Steel Engineers:

☐ Application blank

☐ Data

Name_____

Title_____

Company_____

Mailing Address_____

Mail this coupon to:

Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Penna.

"Every dollar --double duty . . ."

HARVEY S. FIRESTONE, JR.
Chairman, The Firestone Tire and Rubber Company

"Every dollar invested in U.S. Defense Bonds does double duty. Through the Payroll Savings Plan we help in the building of national defense and, at the same time, provide for personal security in the years to come. The Firestone organization is proud that more than 29,000 of our employees are participating in the Payroll Savings Plan."

Do America's wage earners appreciate that double duty feature of Defense Bonds? Let's take a quick look at a few figures:

- 7,500,000 employed men and women are investing *one hundred and fifty million dollars per month* in Defense Bonds through the Payroll Savings Plan.
- The number of Payroll Savers is going up steadily.
- In the first six months of this year, sales of Series E $25 and $50 Bonds—the payroll savers' sizes—totaled 33,946,000 pieces—an increase of 22% over the corresponding period of 1951.
- Sales of E Bonds in January-June, 1952 totaled $1,715 million—5% more than in the same period of 1951. (The Payroll Savings Plan is the backbone of E Bond sales.)
- Today Americans hold a cash value of more than $49 billion in Savings Bonds. Their holdings of E Bonds—the Series bought by Payroll Savers—are now $35 billion—$5 billion greater than at the end of the war.

What are *you* doing to help *your* employees build for national defense and personal security?

If you have a Payroll Savings Plan, and participation is less than 50%, conduct a person-to-person canvass of employees of your plants and offices. Make sure that a Payroll Application Blank is placed in the hands of every employee. He or she will do the rest. Participation in your Plan will jump to 60%, 70%—even higher, as it has in hundreds and hundreds of plants that have conducted similar canvasses.

If you do not have the Payroll Savings Plan, phone, wire or write to Savings Bond Division, U.S. Treasury Department, Suite 700, Washington Building, Washington, D. C. Your State Director will help you to install the Plan—or to conduct a person-to-person canvass.

The U. S. Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

Contributed in the public interest by

IRON AND STEEL ENGINEER

440 Fourth Ave., New York 16, N. Y. Primarily an introduction to the field of engineering materials, it includes the basic concepts of physics, chemistry, geology, and various fields of engineering, and their application to the problems of occurrence, production, properties, and uses of the various materials of engineering.

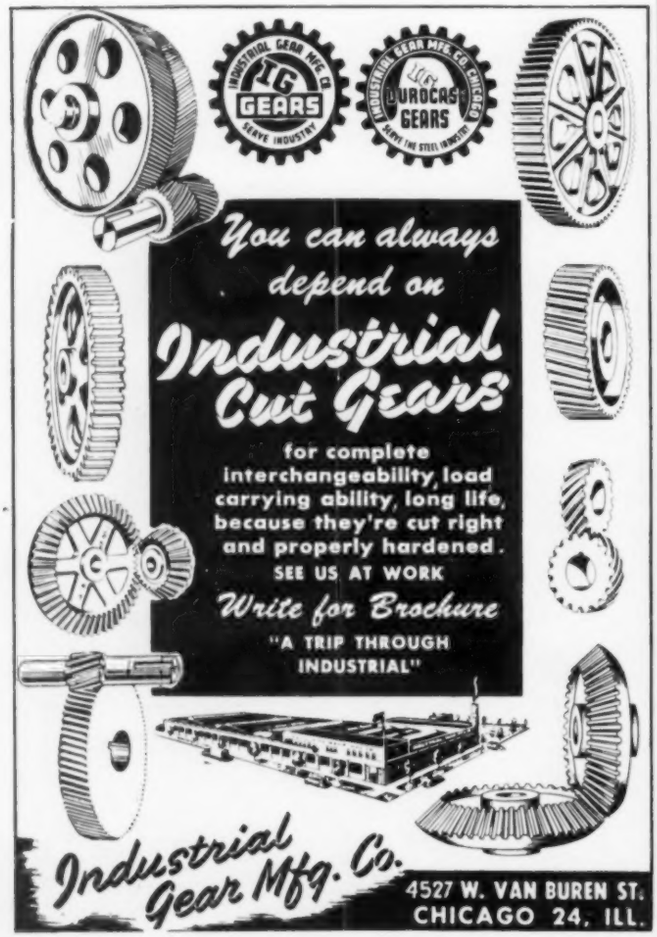
▲ **"Advanced Mechanics of Materials,"** by Fred B. Seely and James O. Smith, has been published recently in a second edition by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y. The new volume, 680 pp, 6 x 9 in., price $8.50, is essentially a new book, though the main objectives are the same as in the earlier edition. Methods of analysis are given careful attention, with equal emphasis on the engineering evaluation and interpretation of the analyses as influenced by the assumptions made and principles used. Prepared primarily for advanced undergraduate students, the material should prove of interest to design and research engineers.

▲ **"Die-Casting,"** by Charles O. Herb, Second Edition, 310 pp, 6 × 9 in., has been extensively revised to cover every phase of the industry. The chapters on die-casting machines, die-casting alloys, and steels for dies and die components have been greatly revised, with up-to-date examples of die-casting techniques being added. As in the previous edition there is a profusion of illustrations that make the presentation vivid and easy to follow. Published by the Industrial Press, 140-148 Lafayette St., New York 13, N. Y., the book is priced at $4.50.

▲ **"Forging and Forming Materials,"** by S. E. Rusinoff, 279 pp, 5½ × 8½ in., $3.95, has been published by the American Technical Society, Chicago 37, Ill. It is aimed at presenting a fuller understanding of the processes used in metal forming. There are chapters on impact forging, press forging, upset forging, extrusion, heat treatment of forgings, cleaning and finishing forgings, inspection, safety, metal quality, and the designing of forgings and tools and dies. Abundantly illustrated with more than two hundred photographs and diagrams, the text thoroughly covers the many improvements that have been made in the field. Included are tables of substitute metals which may be safely employed for the unavailable originals, particularly valuable during the present metal scarcity.

▲ **Standard Metal Directory,** 1952 edition was just published by the Atlas Publishing Company, Inc., 425 West 25th St., New York, N. Y.; 927 pp, price $15.00. It has been enlarged and completely revised. The directory is divided into four sections: iron and steel plants; ferrous and non-ferrous metal foundries; metal rolling mills; smelters of non-ferrous metals. The directory contains more than 10,000 detailed reports on steel mills, foundries, smelters, rolling mills and non-ferrous metal plants located in the United States and in Canada. The plants are listed geographically and alphabetically. The reports give the name of the company, its capitaliza-

(*Please turn to Page 230*)



Hot Blast
VALVE SEATS
Bosh Plates
Mantle Plates
Cinder Notches
Tuyeres
Tuyere Coolers
Hot Blast Valves
and Valve Seats
Dependability and Long Service at no Extra Cost
Smeeth-Harwood moulding and melting techniques, perfected through the years, produce dense castings, free of blow holes, and of uniform wall thickness.
The superior quality assures longer, more dependable service at no extra cost.
RESULTS TALK—Place your next order for Valve Seats with us and compare performance.
SMEETH-HARWOOD COMPANY
2401-09 West Cermak Road, Chicago 8, Illinois
Superior Blast Furnace Copper Castings Exclusively

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

BIRMINGHAM DISTRICT

DIXIE ENGINEERING COMPANY
"Manufacturer's Agents"
P. O. Box 750 — 814 Protective Life Building
BIRMINGHAM 3, ALABAMA
Sabel E. Baum — Telephone 7-6376

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CORP.

EHRET AND KINSEY
Board of Trade Bldg., 141 West Jackson Blvd.
Chicago 4, Illinois — Wabash 2-0449
Representing
THE CLEVELAND WORM AND GEAR CO.
Worm Gearing and Worm Gear Speed Reducers
THE FARVAL CORPORATION
Farval Centralized Lube Systems
LUBRICATION PRODUCTS COMPANY
Stapax Journal Box Lubricators
AMERICAN FLEXIBLE COUPLING COMPANY
Amerigear Flexible Couplings
WALDES KOHINOOR, INCORPORATED
Truarc Retaining Rings

PHILADELPHIA DISTRICT

TOWLE & Son Co.
18 West Chelton Ave. — GE 8-1930
PHILADELPHIA 44
Representing:
THE TOOL STEEL GEAR AND PINION CO.
Cincinnati 16, Ohio

MOFFATT BEARINGS COMPANY
1640 Fairmount Avenue
PHILADELPHIA 30, PA.
Phone: POplar 5-3443
A Complete Anti-Friction Bearing Service
Ball, Roller, Thrust and Needle

PITTSBURGH DISTRICT

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2220 OLIVER BUILDING PITTSBURGH 22, PA.
Cable Address "FOSTER" Pittsburgh

BLAST FURNACE
CONTRACTORS
• Construction • Rebuilds • Linings
• Maintenance • Repair
AFFILIATED FURNACE, INC.
4064 Penn Avenue, Pittsburgh 24, Pa.

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
Park Building — PITTSBURGH, PA.
COurt 1-7032

PATTERSON-EMERSON-COMSTOCK, INC.
ENGINEERS AND CONSTRUCTORS
Specializing in Steel Mill Construction
313 E. Carson Street
Pittsburgh 19, Pa.
Phone: EVerglade 1-9800

Auburn & Associates, Inc.
Engineers
ELECTRICAL LAYOUTS FOR STEEL MILLS
923 Penn Ave., Pgh. 22, Pa.
Telephone COurt 1-5014

PITTSBURGH (Continued)

CHEMSTEEL CONSTRUCTION COMPANY, INC.
204 Chemsteel Bldg., Walnut St., Pittsburgh 32, Pa.
Send data on Engineering & Construction facilities for
ACID-ALKALI-PROOF CONSTRUCTION
of pickling and other tanks; flooring.
(TEAR OUT & MAIL WITH LETTERHEAD)

W. G. KERR CO., INC.
520 Oliver Building — PITTSBURGH, PA.
Phone: ATlantic 1-4254
Representing:
FOOTE BROS.—Gears and Speed Reducers
REEVES—Variable Speed Drives
THOMAS—Flexible Couplings
WICHITA—Air Tube Disc Clutches & Brakes
TELSMITH—Telsmith Crushers
CULLEN-FRIESTEDT—Sheet Lifters—Welding Positioners—Track Cranes

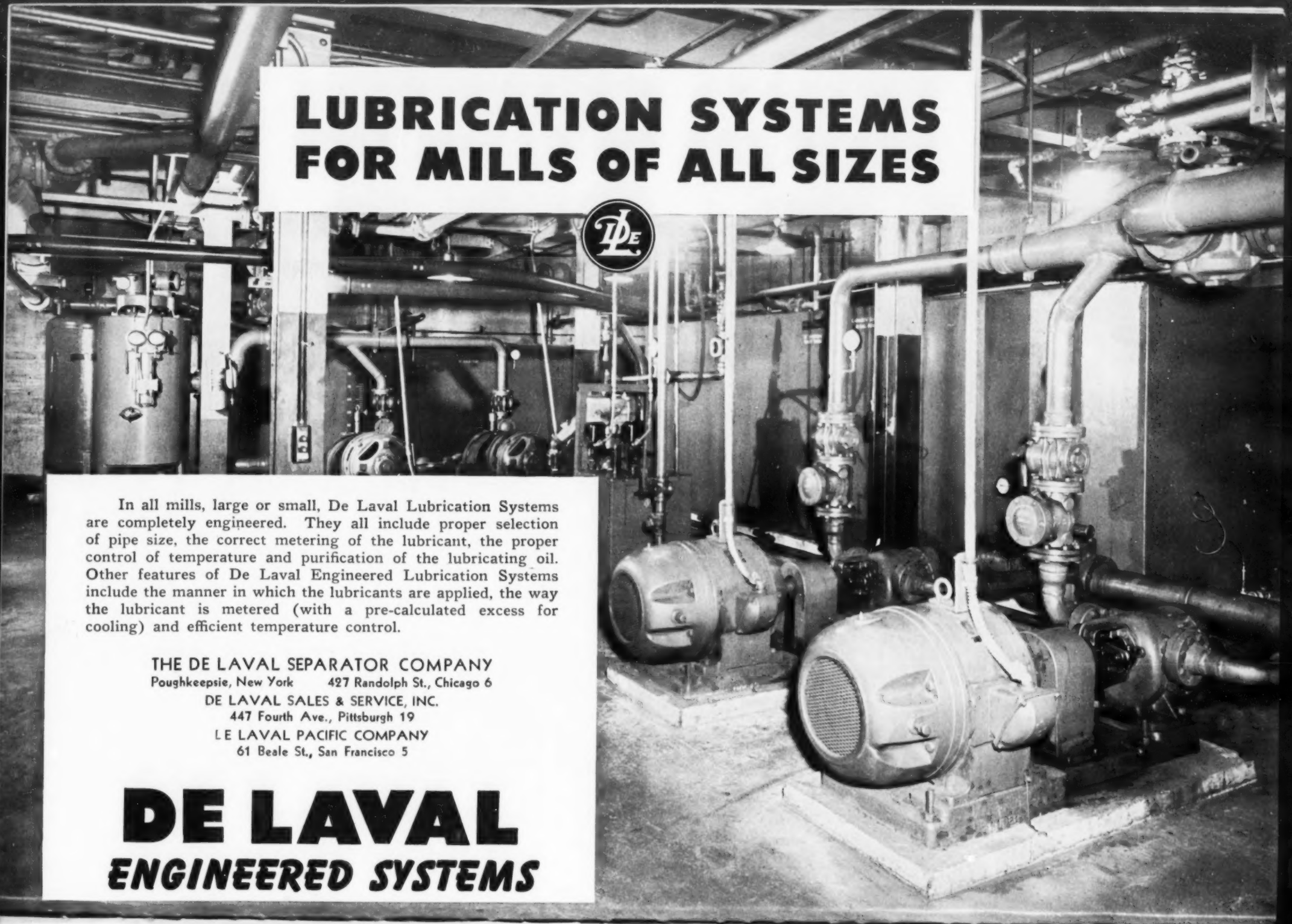
RITTER ENGINEERING CO.
Engineers - Distributors - Contractors
3031 WEST LIBERTY AVE. — Phone:
PITTSBURGH 16, PA. — LOCUST 1-1303
Representing:
TRABON ENGINEERING CORP.
"Centralized Lubricating Systems"

FOR SALE
1600 CFM Ing.-Rand Horiz. Air Compressor, PRE-2, 14" x 23" x 16" cylinders, 100 PSI, 300 HP Westinghouse Motor, 2300 V, 225 RPM. Complete.
TIPPINS MACHINERY CO.
1001 WASHINGTON BLVD. • PITTSBURGH 6, PA.

CONSULTING ENGINEERS

LOYAL R. MILBURN
Consulting Electrical Engineer
Registered State of Michigan
1928 Guardian Building • Detroit 26, Michigan
Telephone: Woodward 3-8706 or Whitmore Lake 5141

LOEDDING ENGINEERING CO., INC.
CONSULTING, DESIGN AND DETAIL
Industrial and Commercial Planning
Bridges, Structures Of All Types
Material Handling
Conveyors, Gantry, Overhead and Jib Cranes
Reninforced Concrete and Foundations
Industrial Piping and Ventilation
ECONOMY BANK BUILDING • AMBRIDGE, PENNA.

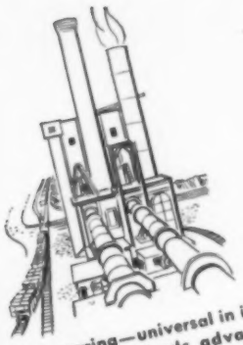


LUBRICATION SYSTEMS FOR MILLS OF ALL SIZES

In all mills, large or small, De Laval Lubrication Systems are completely engineered. They all include proper selection of pipe size, the correct metering of the lubricant, the proper control of temperature and purification of the lubricating oil. Other features of De Laval Engineered Lubrication Systems include the manner in which the lubricants are applied, the way the lubricant is metered (with a pre-calculated excess for cooling) and efficient temperature control.

THE DE LAVAL SEPARATOR COMPANY
Poughkeepsie, New York 427 Randolph St., Chicago 6
DE LAVAL SALES & SERVICE, INC.
447 Fourth Ave., Pittsburgh 19
LE LAVAL PACIFIC COMPANY
61 Beale St., San Francisco 5

DE LAVAL
ENGINEERED SYSTEMS



Worm gearing—universal in its application—affords advantages for almost every power transmission job.

The Cleveland-driven conveyor shown here is feeding dolomite into a rotary kiln at the Basic Refractories Plant at Maple Grove, Ohio.

Steady CLEVELAND drive keeps dolomite rolling along

TO move sized, chemically-treated dolomite to one of its rotary kilns for uniform dead-burning, Basic Refractories, Inc., chose this dependable Cleveland. In service more than 10 years, it has operated steadily, day and night, most of that time.

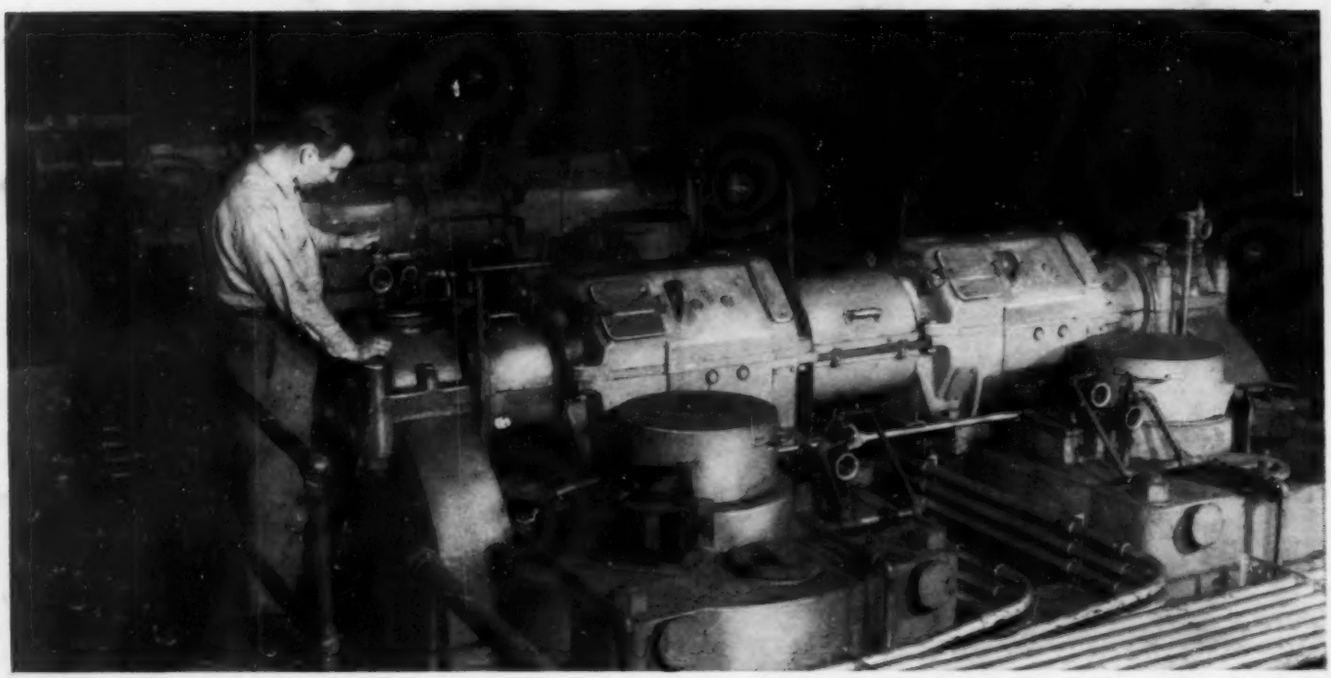
Cleveland is the worm gear speed reducer which assures smooth uninterrupted top-peak production. Backed by 40 years of industrial know-how, Clevelands are found in hundreds of manufacturing plants, operating huge dryers and kilns, belt conveyors, bucket elevators, mixers and agitators, in fact, wherever a fool-proof horizontal or vertical drive is desired—wherever steady production is the key-word.

So whatever your needs, consult the helpful Cleveland engineer in or near your city and see how Cleveland drives can help keep your production schedules rolling. Write now for new Catalog 400. The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

ENGINEERED SYSTEMS



Driving screwdowns on the 70-mph 5-stand cold strip mill at Jones & Laughlin's Aliquippa Works are 10 G-E 75-hp MD mill motors. On ingot buggies, sideguards, tables, and other auxiliaries, too, G-E MD motors give high service continuity.

G-E mill motor, with improved ventilation, lasts longer in steel-mill service

Totally enclosed mill motor dissipates up to 50% more heat; resists corrosion, heat, moisture

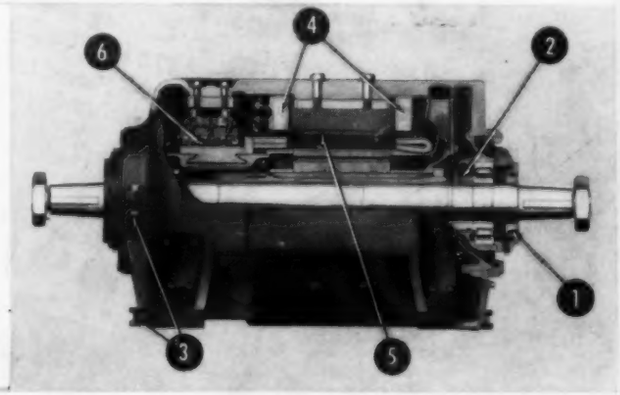
For longer motor life, fewer replacements and less downtime, General Electric MD-600 totally enclosed mill motors are built to last in all kinds of steel-mill conditions—intense heat, corrosive fumes, excessive moisture and mechanical strain.

Take ventilation, for example. An improved system for circulating internal air carries more heat away from the armature, dissipates it through the frame for increased efficiency. Heat-dissipating ability—increased up to 50 per cent—gives a greater margin of safety, helps increase motor life.

You get best results when G-E application engineering teams up these heavy-duty d-c mill motors with co-ordinated G-E control and fast-acting G-E magnetic brakes. For more data, contact your nearest G-E Apparatus Sales Office and ask for Bulletin GEA-4654, or write to General Electric Company, Section 659-87, Schenectady 5, N. Y.

Built extra-tough for extra-tough jobs!

1. Four grease-packed grooves in each end of frame heads keep grease in, dust out.
2. Grease slingers on shaft further protect commutator and windings against possibility of escaping grease.
3. Wide-spread pads at frame joint, and tongued and grooved pads on feet, insure firm support and mounting for brake.
4. Heavy mica and glass insulation, plus insulating pads of waterproof oiled asbestos, protect field coils.
5. Full-length commutating poles for improved commutation permit momentary loads up to 300%.
6. Box-type brush holders, anchored in place by two insulating studs, lessen wear on brushes



GENERAL ELECTRIC

other
uity.

way
ame
ty—
rgin

en-
tors
G-E
rest
etin
any,